(213) 282-9166

1253/IN 105

560 SERIES
MICROPROCESSOR CONTROLLER
FOR PROCESS HEATING APPLICATIONS

INSTRUCTION MANUAL

Volume 1. Installation, Wiring, and Operation

AFTER UNPACKING

Compare the contents of the shipping container against the packing slip. If the instrument was damaged in shipping, report the extent of the damage to the carrier.

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If power to the controller is interrupted within 20 seconds after leaving the Calibration Mode, Memory Data will be lost, and the controller must be reprogrammed. Send the controller to the local Branch Office for reprogramming.

This controller contains Electronic Memories which must be refreshed at least annually. Refer to Section 20 for the recommended practices.

1. DESCRIPTION

The Series 560 Controller is a single zone, stand alone, microprocessor based industrial controller. It is totally self-contained and accepts signals directly from thermocouple, RTD, milliampere, millivoltage and voltage inputs.

All common National Bureau of Standards listed thermocouples can be accommodated and all are linearized to provide high accuracy over the recommended operating temperature range.

Controller outputs include voltage and current level signals, on-off or time-proportioning solid state switching and relay contact closure, and electric actuator positioning. Indicators, High Limit and Low Limit Models complete this line of industrial controllers.

The standard control forms of proportional, automatic reset, and rate are available.

Auto-Manual capability with Bumpless Transfer is also available.

An external setpoint signal can be used with the Remote/Local Option.

Tuning Constants and instrument calibration are front panel adjusted. Digital Setpoint and Process Indication is standard. On Command, the same digital indicator displays the Tuning Constants.

Front Display Deviation Bar with 48 elements. In Setup Mode, bar segment defines the parameter being changed. 4 digit bi-polar continuous process display shows setpoint on command and tuning constants in the Setup Mode (.55 inch high). 4 digit optional setpoint display or 2 digit percent output display (.4 inch high).

An optional second set of Tuning Constants and a second preset setpoint can be selected by an external contact closure.

The 560 Series Controller is designed for industrial environments and features gasketed cases, and sealed operator keyboard switches.

Control Mode Options

The three Control Modes are ON-OFF; the combination of Proportional, Reset and Rate Actions; and Proportional, Reset and Rate with Auto-Manual capability.

The Proportional Action is a continuous linear relationship between the output and input within the proportional band.

With Automatic Reset (Integral) Action, the output of the controller is proportional to the time integral of the deviation of the input and setpoint. This action prevents offset in processes where severe and frequent load changes occur. Reset Windup Inhibition is included with Reset Action to control overshoot by inhibiting reset action during warmup or cooling time. Reset Windup Inhibition is particularly desirable in batch processes where large step changes are likely.

With Rate (Derivative) Action, the output of the controller is proportional to the rate of change of the input. Rate Action corrects the output proportional to the rate of change of a sudden upset, appreciable transfer lag, or a small to moderate amount of dead time.

With Auto-Manual, the controller can be put into the manual mode, allowing the output to be raised and lowered by means of the Increase and Decrease Keys.

2. SPECIFICATIONS

2.1 General

Thermocouple and mV Sensors Minimum Span 8 mVdc. Cold Junction Compensation. The standard upscale TCB can be jumper changed to downscale TCB. For thermocouple break on upscale TCB, the word HIGH is displayed. For thermocouple break on downscale TCB, the word LO is displayed.

Milliampere Sensors 4 to 20 mAdc. 0 to 100.0 display standard.

RTD Sensors 3 wire, 100 ohms platinum (.00385 Ω/Ω/°C).

Source Resistance 0 to 1000 ohms with less than .25% shift in calibration.

Sample Time 2 Samples per second.

Input Reference Ground or floating.

Setpoint Stored digitally in non-volatile memory and changed by [↑] (Increase) and [↓] (Decrease) Keys.

Reset Windup Inhibition Inhibits Reset Term when output is at zero or maximum.

Reference Accuracy ± (.25% of reading +1 LSD) not including conformal error.

Reference Operating Conditions
Ambient Temperature: 25°C.

Operating Power Supply: 120 or 240 Vac, ±1%, 60 Hz.

Rated Operating Conditions
Ambient Temperature: 0 to 55°C.

Operating Power Supply: 120 or 240 Vac, +10%, -15%, at 60 Hz; or 110 or 220 Vac, ±10%, at 50 Hz, by terminal selection.

Humidity: 0 to 70% RH.

Position (tilt): Any position.

Common Mode Rejection: 140 decibels.

Maximum Common Mode Voltage: 120 Vac r.m.s.

Series Mode Rejection: 60 decibels.

Maximum Series Mode Voltage: 5 times span.

Extreme Operating Conditions
Ambient Temperature: -18 to 65°C.

Operating Power Supply: Nominal line voltage ±15%.

Humidity: 0 to 90% RH.

Line Voltage Stability +10% or -15% change in line voltage will not shift control point by more than ±0.1% of span.

Temperature Stability ±6μV/°C maximum, including cold junction tracking.

Power Consumption 15 VA.

Control Action All controllers are shipped with reverse action. Jumper changeable to direct action.

Outputs All isolated from input.
Triac: 120/240 Vac, 150/300 VA pilot duty.

Relay: Form C, 8 A at 120 Vac, 8 A at 240 Vac, resistive 200 VA pilot duty.

Current: 4 to 20 mA into 0 to 750 ohm load; 0 to 10 mA into 0 to 1500 ohm load.

Voltage: 0 to 10 Vdc up to 5 mA (≥2000 ohm load).

Dual Relay Outputs: Form C, 2.5 A at either 120 or 240 Vac, resistive. 75 VA pilot duty.

±511 digits about setpoint with auxiliary output deadband fixed at .5%. Separation of the two outputs is adjustable by the SPREAD Adjustment.

Indicator: Indicator has no output.

Electric Actuator Positioning: Triac switching. 1.5 A at 24 to 240 Vac, 50 mAdc minimum. A .5 Vdc reference signal is available for a 100 to 1000 ohm actuator feedback slidewire. Deadband adjustable to 1, 2, 4 and 8% of proportional band.

Limitrol®: Relay switching. 8 A at 120 Vac, 8 A at 240 Vac, resistive. 200 VA pilot duty.

Alarms Two independent alarms with front LED indication. Alarm setpoint displayed in setup mode and set with front panel INCREASE-DECREASE Keys. One or two of the following types may be specified.

Deviation: Adjustable ±511 digits about setpoint.

Process: Adjustable from 0 to 100% of span (same as S.P. limits).

Deviation Band: Adjustable from 0 to 511 digits. Jumper selectable alarm operation with respect to the energized or de-energized state of the alarm relay.

Form C contacts rated 1 A at 120 Vac resistive load.

Deadband fixed at .5% of span.

Front Display Deviation Bar with 48 elements. In Setup Mode, bar segment defines the parameter being changed. 4 digit bi-polar continuous process display shows setpoint on command and tuning constants in the Setup Mode (.55 inch high). 4 digit optional setpoint display or 2 digit percent output display (.4 inch high).

2.2 Specifications for Setpoint Options 4 and 5

Setpoint Signal Input* 1 to 5 Vdc or 0 to 4 Vdc. 500 k ohms input impedance.

Setpoint Signal Output* 1 to 5 Vdc or 0 to 4 Vdc. 2.5 mAdc maximum output.

Process Signal Output* 1 to 5 Vdc or 0 to 4 Vdc. 2.5 mAdc maximum output.

Feedforward Input Signal* 1 to 5 Vdc or 0 to 4 Vdc. 500 k ohms input impedance.

4 Vdc Output 4.0 mAdc maximum output.

*Jumper selectable 1 to 5 Vdc or 0 to 4 Vdc level for all of these signals.

2.3 Tuning Constants Specifications

Tuning Constants Stored digitally in non-volatile memory and changed by front panel switches.

Rate (Derivative) Adjustable to either 0, .02, .05, .1, .5, 1, 3 or 7 minutes.

Reset (Integral) Adjustable to either 0, .02, .04, .06, .08, .1, .2, .4, .6, .8, 1, 2, 4, 8, 10 or 20 repeats per minute.

Proportional Band Adjustable to either 1, 2, 4, 6, 8, 10, 15, 20, 30, 50, 75, 100 or 200 percent of span.

Second Set of Tuning Constants (Rate, Reset, and Proportional Band Only) Specifications are the same as the First Set above. Second Set available with Setpoint Options 4, 5 and 6.

Second Setpoint Setpoint 2 is an adjustment located under the front door. Available with Setpoint Option 6.

Alarms 1 and 2 Alarm setpoint displayed in Setup Mode and set by means of the front panel ↑ INCREASE and ↓ DECREASE Keys. Process Alarm is adjustable from 0 to 100% of span. Deviation and Deviation Band Alarms are adjustable ±511 counts about setpoint over the entire instrument span. Switching action can be changed by moving a jumper on the Alarm Board. Alarm Deadband is fixed at .5% of span.

Spread Output 2 Setpoint can be set from -511 to +511 digits about Output 1 Setpoint. Output 2 Deadband is fixed at .5% of span.

Load Lineout Adjustable from 0 to 99% in steps of 1%.

Output 1 Limit Adjustable from 10 to 100% in steps of 10%.

Cycle Time Adjustable to either 1, 2, 4, 8, 16, 32 or 64 seconds.

Manual Reset 0 to 99% in steps of 1%.

Deadband Adjustable to either .25, .50, .75 or 1% for ON-OFF Outputs on Output 1. Output 2 Deadband fixed at .5% of span. Electric Actuator Positioning Model Deadband adjustable to either 1, 2, 4, or 8% of Proportional Band.

Controller Calibration
CAL 1 Position: Calibrating the A to D Converter.

CAL 2 Position: Calibrating the Cold Junction Circuit.

Table 3-1. Thermocouple Range Codes

Range	Code Number for Range and Thermocouple										
	J	K	T	S	R	B	C	G	F	Ni/Ni Mo	W3/W25
-350 to 400°F			202								
-350 to 200°F			201								
-300 to 300°F			203								
-300 to 1000°F		046									
-200 to 200°F	009										
-150 to 400°F			204								
-100 to 500°F			200								
-100 to 1100°F	008										
0 to 400°F	012		205								
0 to 600°F	015	027									
0 to 700°F			206								
0 to 800°F	016										
0 to 1000°F	017	034									
0 to 1200°F	018	042									
0 to 1600°F	019	029									
0 to 2000°F		030								254	
0 to 2200°F									252		
0 to 2500°F		031									
1000 to 2500°F				041	039						
0 to 3000°F				036	038						120
500 to 2200°F										256	
500 to 3300°F					044	100		118			
1000 to 3000°F						102					122
500 to 4200°F							109	114			
800 to 1800°F		045									
-200 to 400°C			209								
-200 to 200°C			207								
-200 to 100°C			208								
-150 to 150°C	010	013									
-100 to 300°C			211								
0 to 300°C	021										
0 to 400°C	022		213								
0 to 600°C	024	028									
0 to 800°C	025	032									
0 to 1000°C		033								255	
0 to 1200°C					043				253		
0 to 1400°C		035									
0 to 1600°C				037	040						121
500 to 1800°C						104					
0 to 2000°C							111				
0 to 2200°C							112				
500 to 2300°C								119			

Symbols for Thermocouple Wire

ANSI Symbol	Wire Combination
J	Iron-Constantan
K	Chromel-Alumel* Tophel-Nial** T1-T2***
T	Copper-Constantan
S	Platinum, 10% Rhodium-Platinum
R	Platinum, 13% Rhodium-Platinum
B	Platinum, 30% Rhodium-Platinum, 6% Rhodium

Barber-Colman Symbol	Wire Combination
C	Tungsten, 5% Rhenium—Tungsten, 26% Rhenium
G	Tungsten—Tungsten, 26% Rhenium
F	Platinel 5355—Platinel 7674 (Platinel II****)
W3/W25	Tungsten, 3% Rhenium—Tungsten, 25% Rhenium
Ni/Ni Mo	Nickel—Nickel, 18% Molybdenum

TRADEMARKS
*Hoskins Mfg. Co.
**W.B. Driver Co.
***Driver Harris Co.
****Engelhard Industries

3. MODEL NUMBER CODES

56□□-□□□□□-□□□-□-□□

CONTROL MODE
- **1** = ON-OFF (Only with Output 1 Options 1, 2, 8, 9, A, C or E)
- **4** = Proportional, Reset, and Rate Load Line Out included
- **5** = Option 4 above with Auto-Manual. Display Option 3 is required

OUTPUT 1
- **1** = Triac
- **2** = 8 A Relay. Not available with Setpoint Option 4 or 5.
- **3** = 4 to 20 mAdc, reverse acting
- **4** = 0 to 10 mAdc, reverse acting
- **5** = 0 to 10 Vdc, reverse acting
- **6** = Electric Actuator Positioning with Slidewire Proportioning Feedback. Must specify Output 2, Option 6.
- **8** = High Limitrol, Manual Operation*
- **9** = Low Limitrol, Manual Operation*
- **A** = High Limitrol, Automatic Reset*
- **C** = Low Limitrol, Automatic Reset*

*Limitrols are available only with Control Mode Option 1, Output 2, Option 0 and Setpoint Option 2 or 3.

- **E** = 2.5 A Relay. Must specify Output 2, Option 0 or E.

OUTPUT 2
- **0** = None
- **1** = Triac, ON-OFF
- **2** = 8 A Relay, ON-OFF. Not available with Output 1, Option 2 or E; Setpoint Option 4 or 5.
- **6** = Electric Actuator Positioning with Slidewire Proportional Feedback. Available only with Output 1, Option 6.
- **E** = 2.5 A Relay. Available only with Output 1, Option E.

SETPOINT
- **2** = Internal Setpoint
- **3** = Limitrol with remote reset. If remote reset is not required, specify Setpoint Option 2 above.
- **4** = Remote-Local Setpoint. Includes process signal output, feedforward input, setpoint signal output, second set of tuning constants, and remote reset inhibition. Must specify Display Option 3.
- **5** = Trim Setpoint. Includes process signal output, feedforward input, setpoint signal output, second set of tuning constants, and remote reset inhibition. Must specify Display Option 3.
- **6** = Two selectable setpoints, second set of tuning constants, and remote reset inhibition. Must specify either Alarm Option 0, 7, 8 or 9. Must specify Display Option 3.

DISPLAYS
- **1** = Digital Process Meter with Setpoint Display on Command. Must specify Deviation Bar Calibration Option 0.
- **2** = Display Option 1 and Deviation Bar Meter
- **3** = Display Option 2 and a Second Digital Meter for Setpoint and Percent Output

INPUT RANGE CODE
See Tables 3-1, 3-2, and 3-3.

DEVIATION BAR CALIBRATION

Option Number	DISPLAY XXXX or XXX	XXX.X or XX.X	XX.XX or X.XX	X.XXX or .XXX	Count Limitations
0	None	None	None	None	Not Applicable
2	±24	±2.4	±.24	None	Only with spans less than 1300 counts*
3	±48	±4.8	±.48	None	Only with spans less than 2400 counts*
4	±120	±12.0	±1.20	None	None
5	±240	±24.0	±2.40	±.24	None
6	±480	±48.0	±4.80	±.48	None

***Example of a count:** **200.0 displayed = 2,000 counts**
10.00 displayed = 1,000 counts

ALARMS
- **0** = None
- **1** = Dual Process Alarms
- **2** = Dual Deviation Band Alarms
- **3** = Dual Deviation Alarms
- **4** = Deviation Alarm and Deviation Band Alarm
- **5** = Deviation Alarm and Process Alarm
- **6** = Deviation Band Alarm and Process Alarm
- **7** = Single Process Alarm*
- **8** = Single Deviation Band Alarm*
- **9** = Single Deviation Alarm*

*Available only with Setpoint Option 6.

HOUSINGS
- **0** = Panelmount
- **1** = Without Housing (Order A-12044-XXX Housing separately from Table 2)
- **2** = Panelmount with Conduit Box

SPECIAL FEATURES
Insert 00 for None.

INDICATOR MODEL NUMBER CODE

Write the Entire 15-Digit Code in the Blocks when Ordering

5660-0□□□-10□-□-□□

OUTPUT
- **0** = None
- **1** = Indicator and 1 to 5 Vdc Process Output Signal

INPUT RANGE CODE
(See Tables)

HOUSINGS
- **0** = Panelmount
- **1** = Without Housing (Order A-12044-XXX Housing separately from Table 2)
- **2** = Panelmount with Conduit Box

ALARMS
- **0** = None
- **1** = Dual Process Alarms

SPECIAL FEATURES
Insert 00 for None

Table 3-2. Milliampere and Millivolt Range Codes

Range Code	Input	Display
400	0 to 16 mV	0 to 1600
401	0 to 10 mV	0 to 10.00
402	0 to 25 mV	0 to 25.00
403	0 to 50 mV	0 to 50.00
404	-5 to 5 mV	-5.00 to 5.00
407	0 to 50 mV	150 to 600
408	0 to 50 mV	-1.00 to 28.00
409	0 to 50 mV	500 to 1500
410	2.42 to 13.89 mV	0 to 4000
411	0 to 50 mV	0 to 250.0
412	0 to 50 mV	0 to 100.0
413	-5.84 to 5.84 mV	-150 to 150
414	0 to 20 mV	0 to 500
415	0 to 50 mV	0 to 300
416	0 to 35 mV	600 to 1300
418	-5.309 to 5.309 mV	-200 to 200
420	0 to 10 mV	100.0 to 200.0
701		
702		
800	0 to 10 mV	1800 to 3200
801	0 to 100 mV	0 to 100.0
802	0 to 10 V	0 to 100.0
803	0 to 5 V	0 to 100.0
804	0 to 5 V	0 to 250.0
805	1 to 5 V	0 to 300
807	0 to 10 V	0 to 500
808	0 to 200 mV	0 to 200.0
809	0 to 10 V	-150 to 400
810	0 to +10 V	40.0 to 90.0
811	0 to 10 V	-1.00 to 4.00
812	0 to 10 V	0 to 500
813	0 to 100 mV	-25.0 to 0.0
814	1 to 5 V	0 to 100.0
815	0 to 300 mV	0 to 300
817	0 to 2.5 V	0 to 2500
818	0 to 3 V	0 to 3000
819	0 to 100 mV	1100 to 2000
820	0 to 100 mV	1000 to 2200
821	0 to 100 mV	1300 to 2000
822	0 to 4 V	0 to 400

Range Code	Input	Display
823	1 to 5 V	-350 to 400
824	1 to 5 V	-150 to 300
825	0 to 100 mV	1500 to 3500
826	0 to 5 V	0 to 3000
827	0 to 5 V	0 to 70.0
828	0 to 5 V	0 to 140.0
829	0 to 10 V	0 to 1000
830	0 to 75 mV	0 to 3000
831	0 to 100 mV	0 to 2000
832	1 to 5 V	0 to 150.0
833	1 to 5 V	-1.50 to 1.50
834	1 to 5 V	0 to 500
835	1 to 5 V	0 to 500
836	1 to 5 V	0 to 400
837	1 to 5 V	0 to 1000
900	4 to 20 mA	0 to 100.0
901	4 to 20 mA	1400 to 2400
902	4 to 20 mA	0 to 50.0
903	4 to 20 mA	0 to 14.00
904	4 to 20 mA	0 to 5.00
905	4 to 20 mA	0 to 200.0
906	4 to 20 mA	-50 to 300
907	4 to 20 mA	0 to 5000
908	0 to 20 mA	2.200 to 2.700
909	0 to 20 mA	0 to 400
910	4 to 20 mA	2.400 to 2.900
911	4 to 20 mA	0 to 400
912	4 to 20 mA	1500 to 3000
913	4 to 20 mA	-3 to 1
914	4 to 20 mA	0 to 6.00
915	4 to 20 mA	50.0 to 150.0
916	4 to 20 mA	0 to 500
917	4 to 20 mA	-100 to 100
918	4 to 20 mA	0 to 18.00
919	0 to 32 mA	450 to 850
920	4 to 20 mA	0 to 15.00
922	4 to 20 mA	0 to 1000
923	4 to 20 mA	0 to 140.0
924	4 to 20 mA	-.300 to .300

Table 3-3. Resistance Temperature Detector Range Codes

(RTD) Ranges (100 ohm Platinum Resistance Bulb)

Code	Range	Display
500	0 to 100°F	0 to 100.0
501	0 to 200°F	0 to 200.0
502	0 to 300°F	0 to 300.0
503	0 to 400°F	0 to 400
504	0 to 600°F	0 to 600
505	0 to 800°F	0 to 800
506	0 to 100°C	0 to 100.0
507	0 to 200°C	0 to 200.0
508	0 to 300°C	0 to 300.0
509	0 to 400°C	0 to 400
511	-300 to 0°F	-300 to 0
513	-100 to 0°F	-100 to 0
514	-100 to 100°F	-100 to 100
515	-200 to 200°F	-200 to 200
516	-200 to 0°C	-200 to 0
517	-100 to 0°C	-100 to 0
518	-100 to 100°C	-100 to 100
520	0 to 500°C	0 to 500
523	-100 to 500°F	-100 to 500

4. MOUNTING

4.1 Housing

The Series 560 can be mounted in any position.

After the cutout is made in the panel, proceed as follows to install one instrument. Unscrew the two mounting bracket screws. The brackets can be slid back down into the housing. Place the housing in the panel cutout. Tighten the mounting bracket screws until the brackets hold the housing snugly against the panel.

CAUTION

Do not over-tighten the mounting bracket screws. Over-tightening these screws could distort the housing.

4.2 Controller

After the housing is mounted in the panel, push the controller firmly into it.

The housing locking screw at the bottom of the front panel, in the middle, is the fastener for the instrument.

Do not push controller further, but, instead, turn screw clockwise about 1/4 turn to hold the controller in its housing.

To remove the controller from its housing, turn the screw counterclockwise about 1/4 turn, and pull the controller forward by means of the slots on the underside of the front bezel.

5. POWER WIRING

Instrument power switch and instrument fuses are included for illustrative purposes only. Consult local codes and appropriate wiring standards.

Connect L1 to Terminal 6 for 240 Vac operation.
Connect L1 to Terminal 5 for 120 Vac operation.
Connect L2 to Terminal 4.
Connect a good earth ground to Terminal 14.

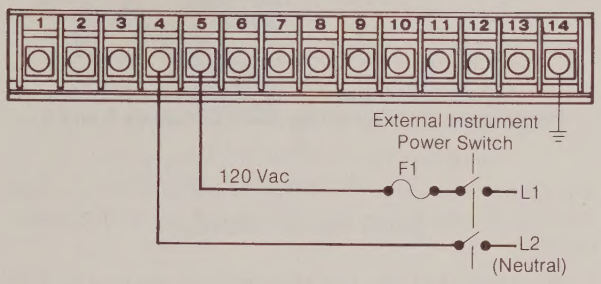


Figure 5-1. 120 Vac Power Supply Wiring

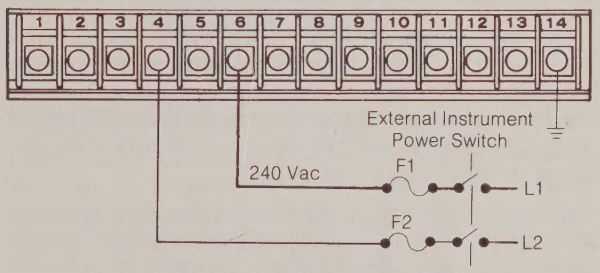


Figure 5-2. 240 Vac Power Supply Wiring

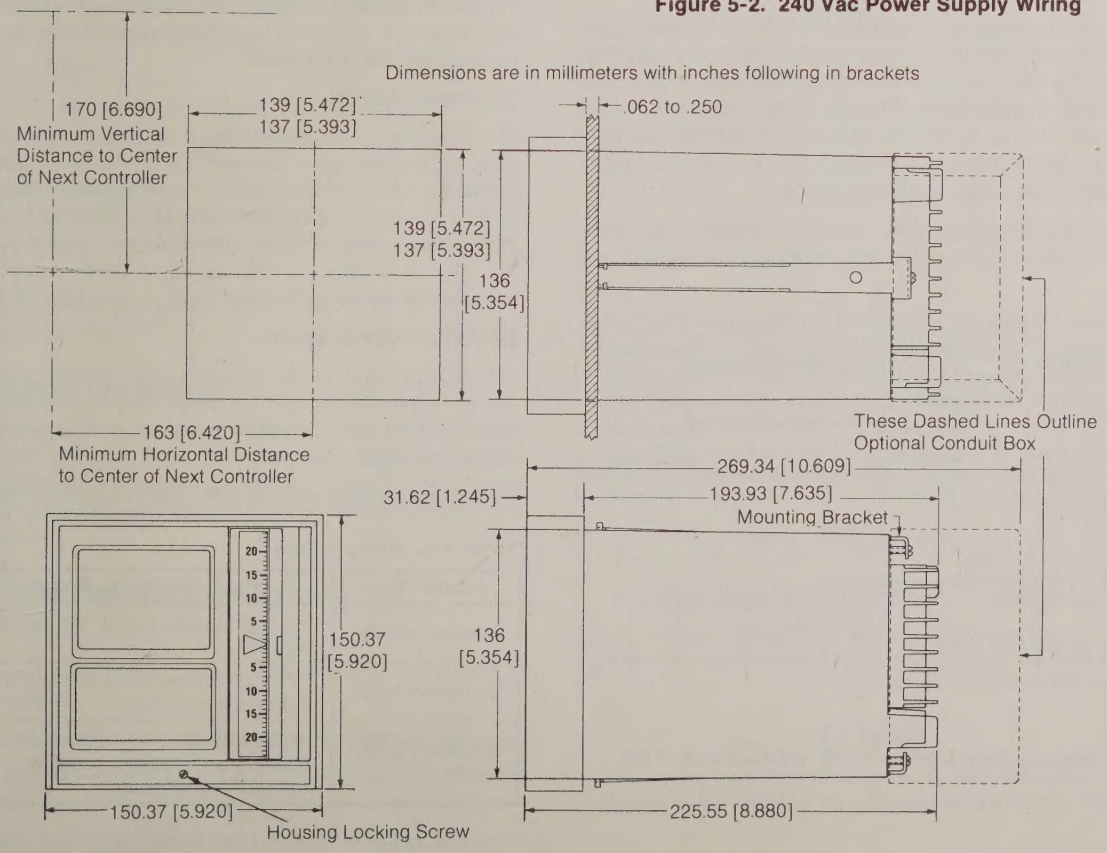


Figure 4-1. Mounting Dimensions

6. INPUT WIRING

6.1 Thermocouple, Millivolt, Volt, and Milliampere

Figure 6-1 shows wiring.

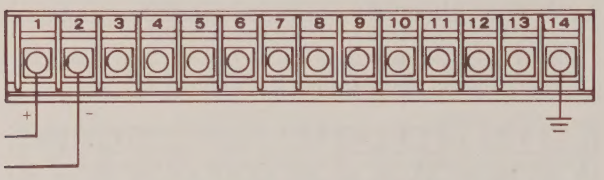


Figure 6-1. Input Wiring, Thermocouple, Milliampere, or Millivolt Input on Terminals 1 and 2

Any millivolt span within the range from 8 to 64 mVdc. Cold Junction compensation is standard with all thermocouple ranges.

Total resistance of leadwire and thermocouple may be 0 to 1000 ohms, .25% of full scale maximum shift with a 1000 ohm source.

Do not place power wiring and thermocouple wiring in the same conduit or wiring trough. The wires from several thermocouples may be in the same conduit or wiring trough. Twist the input wires and also shield them to maintain the integrity of the input signal. Always take this precaution on input wires, say above 10 feet and up to 1000 feet.

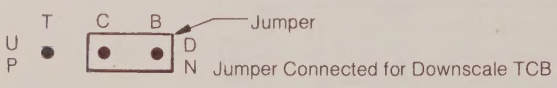
If shielded thermocouple leads are used, the shields should be insulated electrically and terminated at one location, preferably the chassis of the Series 560.

When the Series 560 is ordered, the type of thermocouple desired is specified. The Barber-Colman Thermocouple Catalog lists a complete selection of thermocouple assemblies and thermocouple extension leadwire. Thermocouples should never be wired to the Series 560 with ordinary copper wire. Wire only with thermocouple extension leadwire such as that specified in the Barber-Colman Catalog.

Observe the correct thermocouple and thermocouple extension wire polarity. The negative wire of both is usually coded red.

The standard upscale TCB action can be jumper changed to downscale TCB action. For thermocouple break action on upscale TCB, the word HIGH is displayed. For thermocouple break action on downscale TCB, the word LO is displayed.

This pattern of pins is on the large flat Main Board in the Controller. This particular pattern is one-third of the way forward from the back on the right side of the Controller.



There are three pins under the letters TCB. Connect Jumper over the left two pins for Upscale TCB action. Connect Jumper over the right two pins for Downscale TCB action.

Figure 6-2.
Changing from Upscale TCB to Downscale TCB

6.2 RTD Input

Figure 6-3 shows wiring. The controller is designed for three wire RTD's (Resistance Temperature Detectors). All leads connecting the RTD to the Controller must be the same size and composition to keep effective leadwire compensation.

Shielding the RTD leads will not be necessary for most applications. If a shield is used, connect the shield to ground at the instrument ground terminal — terminal number 14. Twist unshielded cable three times per foot to reject external interference.

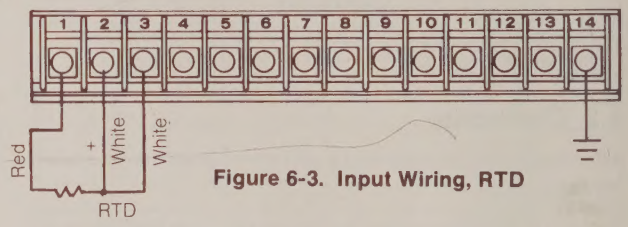


Figure 6-3. Input Wiring, RTD

7. ALARMS

7.1 Alarm Options

Refer to the model number of your 560 Series Controller to determine which alarm option, if any, was supplied with it. Alarm options 1, 2, 3, 4, 5 and 6 have two independent alarm circuits.

7.2 Alarm Description

Process Alarm

This alarm actuates whenever the process signal exceeds the alarm setpoint. Changing the control setpoint does not affect the process alarm trip point.

Deviation Alarm

The Deviation Alarm is arranged such that it actuates whenever the process value exceeds the controller setpoint by a predetermined (alarm setpoint) amount. Deviation Alarms can be field changed to operate on either an increasing or decreasing process signal. They are unidirectional. When the controller setpoint is changed, the deviation alarm moves with it maintaining the same deviation (+ or -) from setpoint.

Deviation Band Alarm

Identical to Deviation Alarm, except it is bi-directional. A deviation of the process signal from control setpoint, exceeding the alarm setpoint value, in either a positive or negative direction, will trip the alarm relay.

Alarms are shipped with the relay action shown in Table 7-1.

Table 7-1. Relay Action

Alarm Type	Relay Action as Shipped
Process Alarm	Relay energizes above the Alarm Setpoint
Deviation Alarm	Relay energizes when the Alarm Setpoint is exceeded
Deviation Band Alarm	Relay energizes when the Alarm Setpoint is exceeded in either direction from setpoint

The relay action in Table 7-1 can be changed in the field by the procedure in paragraph 7.6.

7.3 Calculating Alarm Setpoints

Alarm Deadband is .5% of span. This means that a high alarm will be energized .25% of span above the alarm setpoint, and de-energized .25% of span below the setpoint. A low alarm will energize and de-energize in just the opposite manner.

EXAMPLE 1: Assume controller range is 1000 to 3000°F, Type B Thermocouple.

Alarm 1 is a high process alarm set at 2800°F.

Span = 3000 - 1000 = 2000°F.

.25% × Span = 5°.

Therefore, Alarm will energize at 2805°F.
Alarm will de-energize at 2795°F.

If the alarm must energize at 2800°F, the alarm setpoint should be set at 2795°F. It will de-energize at 2790°F.

EXAMPLE 2: Assume controller range is 1000 to 3000°F, Type B Thermocouple.

Alarm 1 is a high deviation alarm set at +20°F.

Setpoint = 2800°F.

.25% × Span = 5°.

Therefore, Alarm will energize at 2825°F.
(2800 + 20 + 5 Deadband)
Alarm will de-energize at 2815°F.
(2800 + 20 - 5 Deadband)

If the alarm must energize at 2820°F, the alarm should be set at +15°F. It will de-energize at 2810°F.

EXAMPLE 3: Assume controller range is 1000 to 3000°F, Type B Thermocouple.

Setpoint = 2800°F.

Alarm 1 is a deviation band alarm set at ±20°F.

.25% × Span = 5°.

Therefore, Alarm will be energized ≥ 2825°F and ≤ 2775°F.
(2800 + 20 + 5 Deadband)
Alarm will be de-energized between 2775°F and 2825°F.

If the alarm must energize at 2820°F and 2780°F, the alarm should be set at ±15°F.

7.4 Alarm Locations

All alarm circuits are on a single plug-in card located at the left rear of the controller. The card is removed by first removing the aluminum hold down plate, and lifting the card from the Main Circuit Board. The relay action jumpers and the fuses are now accessible.

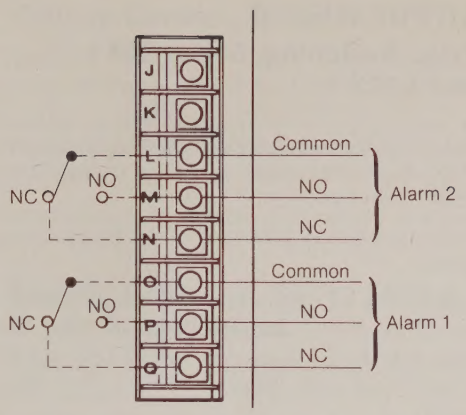
7.5 Rear Panel Alarms Wiring

Figure 7-2 shows wiring for all alarms.

NC means relay contacts are normally closed when alarm is de-energized.

NO means relay contacts are closed when alarm is energized.

Alarm Relay Contact Rating: 1 A at 120 Vac, resistive, Form C Contacts.



Corresponding Front Panel Alarm Light is on when Alarm Relay is energized

Figure 7-2. Alarms Wiring

7.6 Energizing on Either an Increasing or a Decreasing Signal

Alarms are shipped as shown in Table 7-1.

For any Process Alarm ordered, the following applies:

Energizing on an Increasing Process Signal: Alarm Relay energizes on an increasing process signal when jumper is connected between the middle pin (J1 for Alarm 1, J2 for Alarm 2) and pin A. Front Panel light turns on. For the Deviation Band Alarm this means alarm energizes **outside** the Deviation Band.

Energizing on a Decreasing Process Signal: Alarm Relay energizes on a decreasing process signal when jumper is connected between the middle pin and pin B. Front Panel light turns on. For the Deviation Band Alarm this means alarm energizes **inside** the Deviation Band.

Jumpers shown on this figure are connected such that the alarm relay will energize on an increasing process signal.

This means that when either alarm exceeds its setpoint, the appropriate front panel ALARM light will turn on.

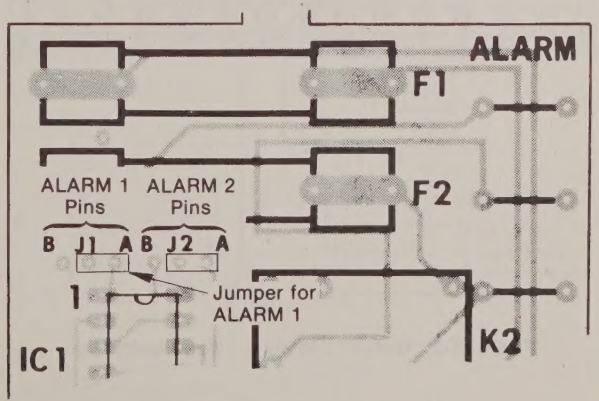


Figure 7-3.
Changing from Energizing on an Increasing Process Signal to Energizing on a Decreasing Process Signal

8. OUTPUT WIRING

8.1 Triac Switching, Series 56X1 and 56XX-1

Figure 8-1 shows the output wiring for Single Output Controller Model 56X1-0, and for Output 1 of Dual Output Controller Models 56X1-1 and 56X1-2.

Figure 8-2 shows Output 2 Wiring for Dual Output Controller Model 56XX-1.

These outputs are solid state Triac Switching Outputs rated 150 VA at 120 Vac Pilot Duty and 300 VA at 240 Vac Pilot Duty. Any voltage from 24 Vac to 240 Vac can be switched, but the voltage switched must be the same phase as the instrument power supply.

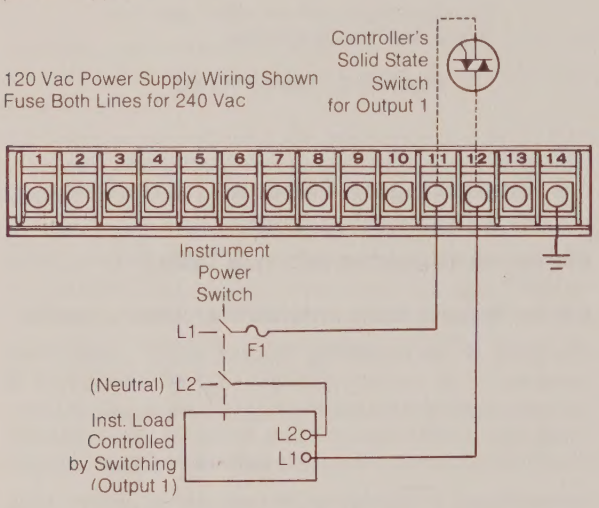

Controller's Solid State Switch for Output 1
120 Vac Power Supply Wiring Shown Fuse Both Lines for 240 Vac
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Instrument Power Switch
L1
F1
(Neutral) L2
Inst. Load Controlled by Switching (Output 1)
L2
L1

Figure 8-1. Output 1 Wiring, Triac Switching

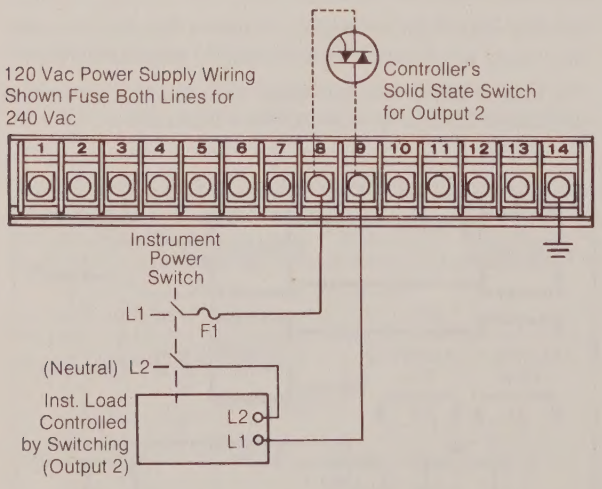

120 Vac Power Supply Wiring Shown Fuse Both Lines for 240 Vac
Controller's Solid State Switch for Output 2
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Instrument Power Switch
L1
F1
(Neutral) L2
Inst. Load Controlled by Switching (Output 2)
L2
L1

Figure 8-2. Output 2 Wiring, Triac Switching

8.2 Relay Switching, Series 56X2, 56XX-2, and 56XE-E

Figure 8-3 shows the output wiring for Single Output Controller Models 56X2-0, 56XE-0 and for Output 1 of Dual Output Controller Models 56X2-1 and 56XE-E.

Figure 8-4 shows Output 2 Wiring for Dual Output Controller Model 56XX-2. Figures 8-3 and 8-4 combined show the Output 1 and Output 2 wiring for Dual Output Controller Model 56XE-E.

On Figures, NC means relay is normally closed when controller output is de-energized. NO means relay is normally open when controller output is de-energized.

The relay is rated 8 A at either 120 Vac or 240 Vac, 200 VA Pilot Duty for Models 56X2 and 56XX-2. The relay is rated 2.5 A at either 120 Vac or 240 Vac, 75 VA Pilot Duty for Model 56XE-0.

If the L2 line is a neutral or ground line, Fuse F2 is not recommended.

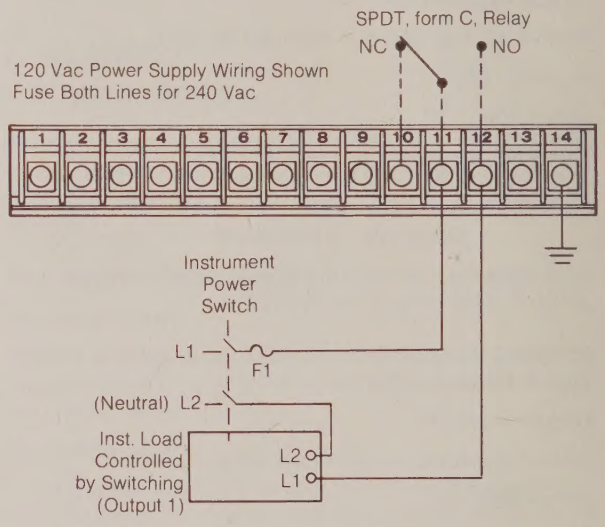

SPDT, form C, Relay
NC
NO
120 Vac Power Supply Wiring Shown Fuse Both Lines for 240 Vac
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Instrument Power Switch
L1
F1
(Neutral) L2
Inst. Load Controlled by Switching (Output 1)
L2
L1

Figure 8-3. Output 1 Wiring, Relay Switching

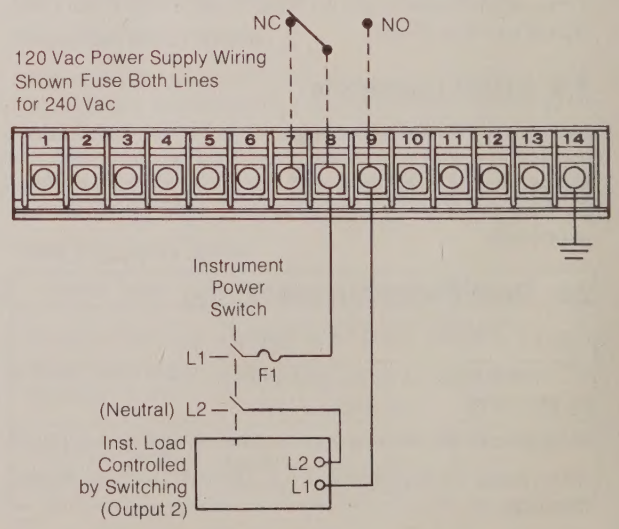

NC
NO
120 Vac Power Supply Wiring Shown Fuse Both Lines for 240 Vac
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Instrument Power Switch
L1
F1
(Neutral) L2
Inst. Load Controlled by Switching (Output 2)
L2
L1

Figure 8-4. Output 2 Wiring, Relay Switching

8.3 Current Control, Series 56X3 and 56X4

See Figure 8-5. Paragraph 8.3 applies to Single Output Models 56X3-0 and 56X4-0, and to Output 1 of Models 56X3-1, 56X4-1, 56X3-2, and 56X4-2.

56X3 is 4 to 20 mAdc, reverse acting output, into a 0 to 750 ohm load.

56X4 is 0 to 10 mAdc, reverse acting output, into a 0 to 1500 ohm load.

The current output on Terminals 12 and 13 is short circuit proof, and isolated. Either terminal can be grounded.

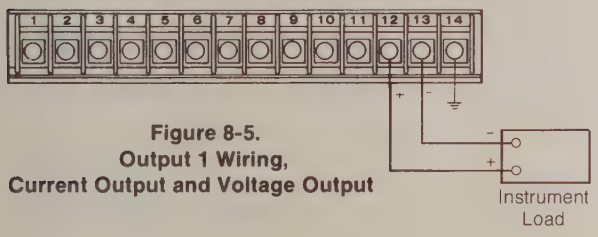


Figure 8-5.
Output 1 Wiring,
Current Output and Voltage Output

8.4 Voltage Control, Series 56X5

See Figure 8-5. Paragraph 8.4 applies to Single Output Model 56X5-0, and to Output 1 of Models 56X5-1 and 56X5-2.

Model 56X5 is a 0 to 10 Vdc, reverse acting output, into any resistive load over 2000 ohms. Do not connect to loads less than 2000 ohms.

The voltage output on Terminals 12 and 13 is short circuit proof.

8.5 Electric Actuators, Series 56X6-6, Proportional Output

See Figure 8-6. These Controllers have solid state Triac Switching Outputs rated 1.5 A, 24 to 240 Vac, 50 mAdc minimum. A .5 Vdc reference voltage is available for a 100 to 1000 ohm actuator slidewire.

Deadband Adjustment: The available deadband settings are 1, 2, 4 and 8% of full Actuator travel. Initially, set deadband at 1%. Increase the deadband setting until cycling stops. To adjust the deadband, see Paragraph 18-4 and Figure 18-5.

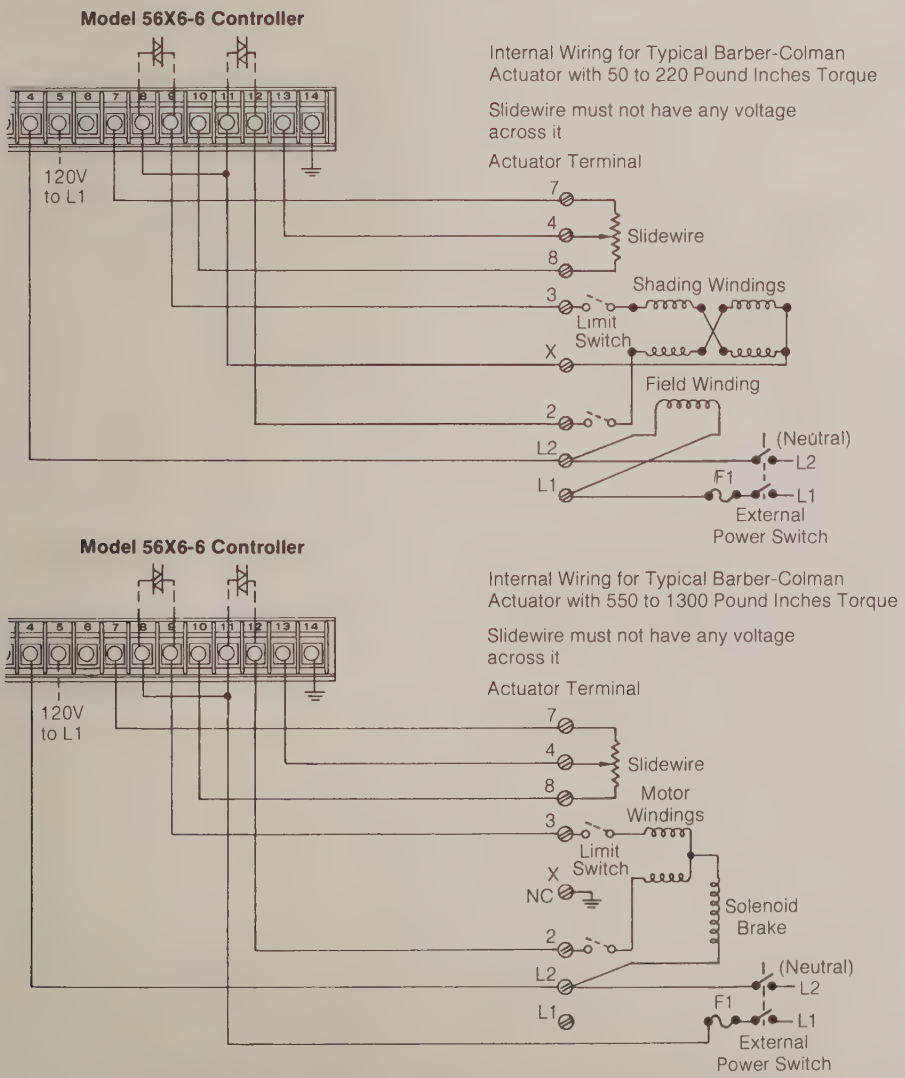


Figure 8-6. Output Wiring for Electric Actuator Positioning Controllers

9. FIELD CHANGES TO OUTPUT CARDS

See Tables 9-1, 9-2 and 9-3.

Do not move any jumpers in either an Electric Actuator Positioning Controller or a Limitrol Controller.

EXAMPLE: A 56X3-2XXXX-XXX-X-XX Controller has a 4-20 mAdc output on Output 1 and an 8 A Relay switching output on Output 2. Using Tables 9-2 and 9-3, the Current Output Card will have J1 = A (reverse acting). The Relay Output Card will have J1 = B (direct acting) and J2 = B. To change the Current Output Card to direct action, change jumper J1 to B. To change the Relay Output Card (Output 2, in this case) to reverse action, change Jumper J1 to A.

Since J1 and J2 on the Relay Output Card are now set at different positions, the Output 2 light will be lit when the relay coil de-energizes. To change it so that the OUTPUT light is lit when the coil is energized, change J2 to A (J2 = A).

Figures 9-1, 9-2 and 9-3 are examples of each card on which jumpers are allowed to be changed.

Table 9-1. Output Card Part Numbers

Card Number	Output
A-12041	Triac Switching
A-12040-1	8 A Relay Switching
A-12041-101	2.5 A Relay Switching
A-12042	4 to 20 mAdc Output
A-12042-100	0 to 10 mAdc Output
A-12042-200	0 to 10 Vdc Output
A-12041 (2) and A-11861 (1)	Electric Actuator Positioning
A-12040-1	Limitrols

Table 9-2. Summary of Jumper Actions on Output Cards

ASSEMBLY		Jumper Symbol	Function	Action
Name	Number			
Relay Switching	A-12040-1	J1	Reverse or Direct Action	Reverse Action: J1 = A. Direct Action: J1 = B.
		J2	OUTPUT Light (1 or 2)	Lit when relay is energized: J1 = A and J2 = A; or, J1 = B and J2 = B. Lit when relay is deenergized: J1 = A and J2 = B; or, J1 = B and J2 = A.
Triac Switching	A-12041	J1	Reverse or Direct Action	Reverse Action: J1 = A. Direct Action: J1 = B.
Current and Voltage Output	A-12042 A-12042-100 A-12042-200	J1	Reverse or Direct Action	Reverse Action: J1 = A. Direct Action: J1 = B. Both OUTPUT lights remain dark.
Electric Actuator Positioning	A-12041 (2) and A-11861 (1)	J1		CW direction: OUTPUT 1 Light is lit. CCW direction: OUTPUT 2 Light is lit. Jumper position **must not** be changed. J1 = A.
Limitrol Cards	A-12040-1	J1, J2		J1 = B, J2 = A. Jumper positions **must not** be changed.

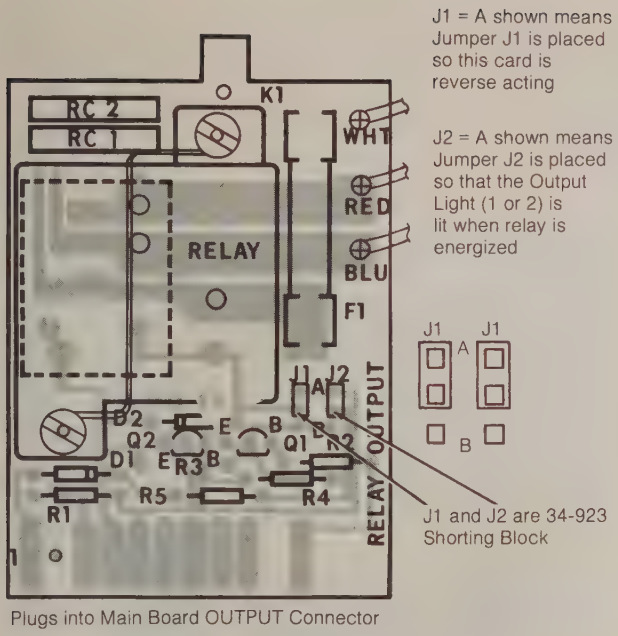


Figure 9-1. Relay Switching Output Cards

Table 9-3. Output Card Jumper Positions When Shipped

Output	Output 1 Jumper Positions		Output 2 Jumper Positions	
	J1	J2	J1	J2
Triac	A	NA	B	NA
8 A Relay	A	A	B	B
2.5 A Relay	A	A	B	B
4 to 20 mAdc	A	NA	NA	NA
0 to 10 mAdc	A	NA	NA	NA
0 to 10 Vdc	A	NA	NA	NA
Electric Actuator	A*	NA	A*	NA
High Limitrol	B*	A*	NA	NA
Low Limitrol	B*	A*	NA	NA

*Do not change
NA means Not Applicable

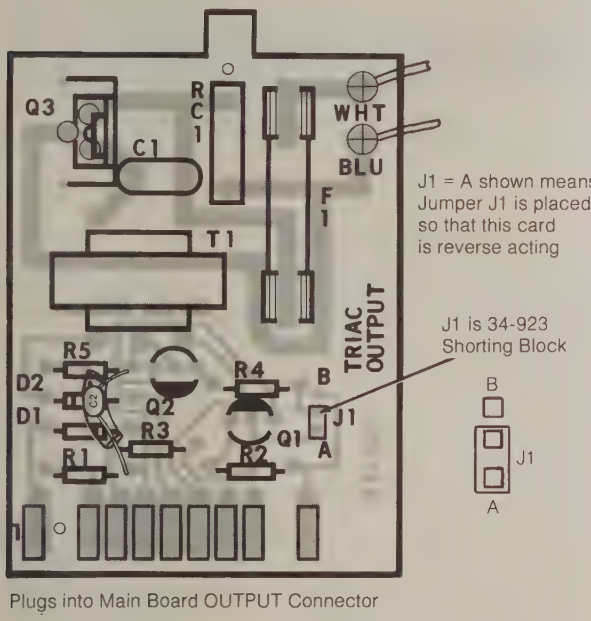


Figure 9-2. Triac Switching Output Card

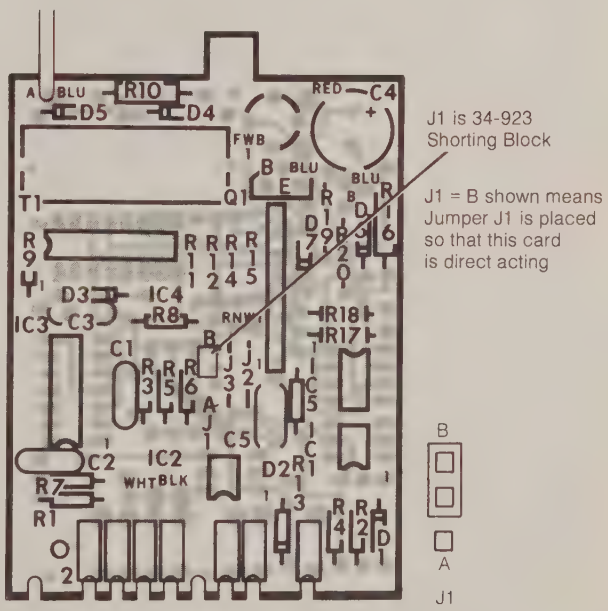


Figure 9-3. Current Output Cards and Voltage Output Card

Table 10-1. Limitrol Switch Action

Process Variable Condition	High Limitrol	Low Limitrol
Process Variable Above Setpoint	Closed between terminals 10 and 11.	Closed between terminals 11 and 12.
Process Variable Below Setpoint	Closed between terminals 11 and 12.	Closed between terminals 10 and 11.
Power Failure	Closed between terminals 10 and 11.	Closed between terminals 10 and 11.

10. LIMITROLS, WIRING AND OPERATION

10.1 Limitrol Models 5618-0, 5619-0, 561A-0 and 561C-0

See Figure 10.1. The output relay rating is 8 A at 120 Vac, 5 A at 240 Vac, resistive.

The Limitrol is a device for shutting down a process and sounding an alarm. When either the setpoint is exceeded or there is a power interruption, the normally closed (NC) contacts open and the normally open (NO) contacts close. See Table 7-1. The Limitrol remains in this state until the setpoint is no longer exceeded, power is restored, and the RESET Key is pressed. On an Automatic Reset Limitrol the RESET Key does not have to be pressed following a power interruption.

If a Limitrol is equipped with Setpoint Option 3, it can be reset remotely by shorting Terminal A to H. See Paragraph 10.3.

Summary

The Manual Reset Limitrol must be reset either by pressing the RESET Key or, on units equipped with Setpoint Option 3, by shorting Terminal A to H:

1. On start-up when power is turned on.
2. After any power failure or interruption.
3. After the process variable (for example, temperature) has exceeded setpoint and then returns to a value where the setpoint is no longer exceeded.

The Automatic Reset Limitrol must be reset either by pressing the RESET Key or, on Limitrols equipped with Setpoint Option 3, by shorting Terminal A to H; after the process variable has exceeded setpoint and then returns to a value where the setpoint is no longer exceeded.

Figure 10-1 is for a Limitrol with local (internal) setpoint. The wiring and operation of a Limitrol with Setpoint Option 3 is in Paragraph 10.3.

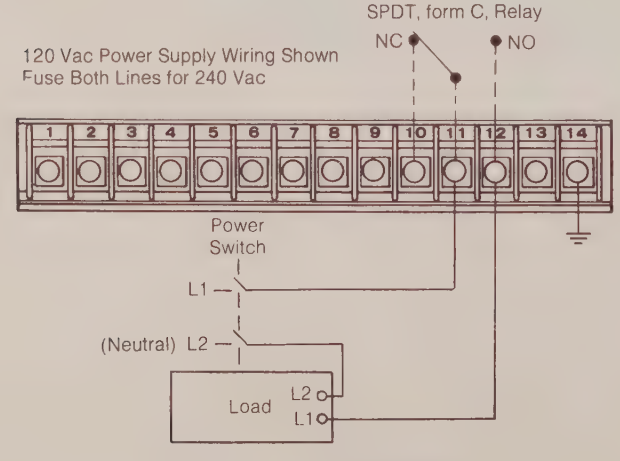


Figure 10-1. Limitrol Wiring

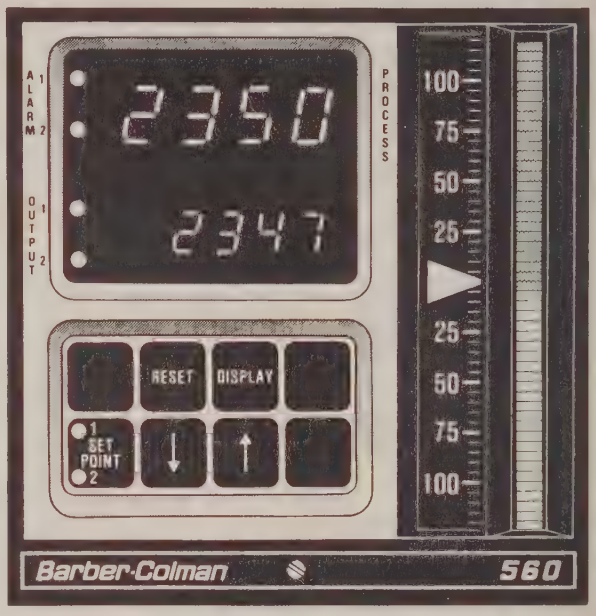


Figure 10-2. Limitrol Front Panel

10.2 Limitrol Operation

Manual Operation Limitrol:
5518-0 Hi Limit and 5519-0 Lo Limit

Auto Start-up Limitrol:
551A-0 Hi Limit and 551C-0 Lo Limit

The Limitrol is a device for shutting down a process or sounding an alarm. The front panel Output 1 lamp lights when the setpoint is exceeded. When either the setpoint selected is exceeded or there is a power interruption, relay contacts open. The Limitrol remains in this condition until the temperature of the process variable is again below setpoint, and the RESET Key is pressed. On application of power, the RESET Key must be pressed for the Manual Operation Limitrols. Auto Start-up Limitrols will start up without having to press the RESET Key, provided the temperature of the process variable is below setpoint.

10.3 Limitrol Setpoint Option 3, Wiring and Operation

The Manual Operation Limitrol Models 5618-0 and 5619-0 are reset either by pressing the RESET Key or, if the Limitrol Setpoint Option 3 is specified, by shorting two rear panel terminals.

On Models 561A-0 and 561C-0 start-up will occur automatically after a power interruption without having to press RESET, providing the process variable does not exceed setpoint. After the process variable is less than setpoint, these models are

reset either by pressing the RESET Key or, if the Limitrol Setpoint Option 3 is specified, by shorting two rear panel terminals (A and H). See Figure 10-3.

Limitrol Setpoint Option 3 Displays
(Either Display Option 1, 2 or 3)

For Either Display Options 1 or 2 When Limitrol is in the RUN Mode, Top Display indicates Process Signal. When the SETPOINT Key is depressed, Top Display indicates Setpoint. There is no bottom display.

For Display Option 3 Top Display is Process Signal. Bottom Display is Setpoint.

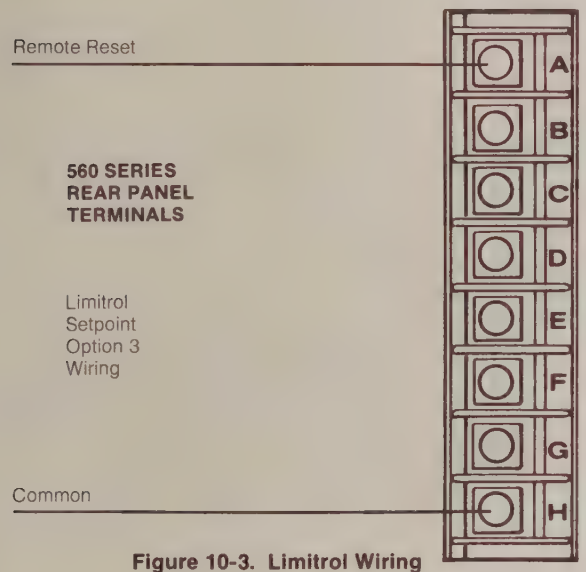


Figure 10-3. Limitrol Wiring

11. INDICATORS

11.1 Indicator Output Option 0, Operation

The Process Variable is shown in the top display. There is no bottom display. The SETPOINT Key LED Number 1 is on whenever power is on.

11.2 Indicator Output Option 1, Wiring and Operation

Process Signal Display is the top display (Display Option 1). There is no bottom display. Setpoint Light 1 is ON when power is turned on to the Indicator.

Maximum current output is 2.5 mAdc. An external short circuit has no effect on indicator action.

Indicator shipped jumpered for 1-5 Vdc span. Figure 12-1 shows location of SPAN Jumper. To change to a span of 0-4 Vdc, move SPAN Jumper to the 0-4 position. These spans are so programmed into the 560 Series Memory that they automatically correspond to the span of the input range of the Indicator

Table 11-1. SPAN Jumper Placement

Jumper Position	Span Selected for the Process OUT Signal
0-4	0-4 Vdc Linear
1-5	1-5 Vdc Linear*

*Shipped in this position.

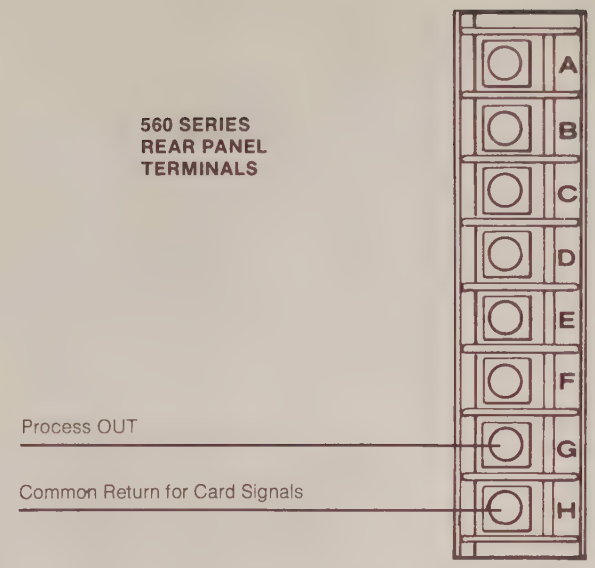


Figure 11-1. Indicator Process Output Signal Wiring

12. INTRODUCTION TO SETPOINT OPTIONS 2, 4, 5 AND 6

12.1 Setpoint Card Jumpers

See the model number systems in Section 3. Refer to the model number which is for either the 560 Controller or Limitrol to determine which Setpoint Option the instrument has. If the 560 Series instrument is a Limitrol, it will have either Setpoint Option 2 or 3. If the instrument is a Controller, it will have either Setpoint Option 2, 4, 5 or 6.

If the instrument is an Indicator, it will have either Indicator Output Option 0 or 1.

Figure 12-1 shows the card that is used for Setpoint Options 3, 4, 5 and 6. The parts on the card vary depending on which option is specified. Figure 12-1 shows customer movable jumpers.

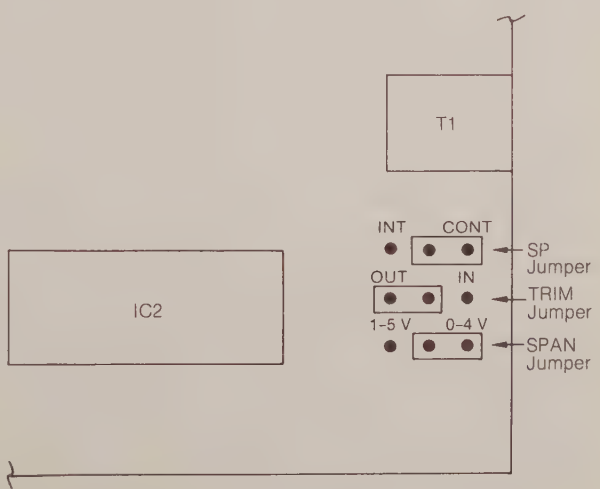


Figure 12-1. Jumpers and Adjustments on Setpoint & Interface Signals Card A-12039-XXX

12.2 Specifications of Second Set of Control Actions

They are identical to the first set; namely:

Rate (Derivative) Action Adjustable to either 0, .02, .05, .1, .5, 1, 3 or 7 minutes.

Reset (Integral) Action Adjustable to either 0, .02, .04, .06, .08, .1, .2, .4, .6, .8, 1, 2, 4, 8, 10 or 20 repeats per minute.

Proportional Band Action Adjustable to either 1, 2, 4, 6, 8, 10, 15, 20, 30, 50, 75, 100 or 200 percent of Span.

Section 18, Setup Mode, describes how to change the first and second sets of control actions.

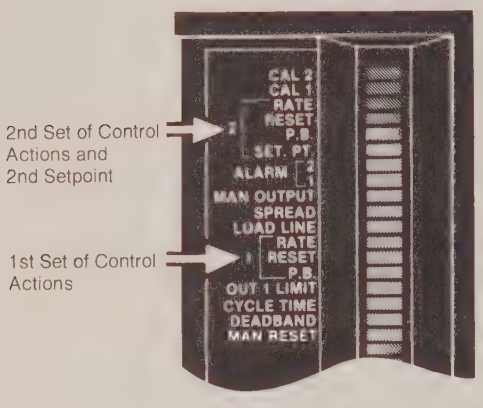


Figure 12-2. Setup Mode Tuning Constants

SETPOINT OUT An outgoing linear voltage setpoint signal that is transmitted by the 560 to either another 560 or a computer.

PROCESS OUT An outgoing linear voltage signal transmitted by either a 560 controller or indicator that represents the process variable.

EXAMPLE: 560 Range Code is 030 (0 to 2000°F, Type K TC)
Process Temperature = 1000°F.

If the PROCESS OUT Signal is 1 to 5 Vdc, then at 1000°F, the PROCESS OUT Signal is 3 Vdc.

REMOTE RESET INHIBITION
Options 4, 5 and 6

Remote Reset Inhibition is useful in some systems either at the start-up of a process or when a sustained offset of process temperature from setpoint temperature exists. In conditions like these the continuous error signal may cause the process temperature to greatly overshoot setpoint. Contact closure between terminals B and H can be used to disable the reset action of the controller at such times.

FEEDFORWARD IN
Options 4 and 5

1-5 Vdc linear signal, isolated from the input of the controller, with an input impedance of 500 k ohms. Signal can be jumper changed to 0-4 Vdc. See Tables 15-1 and 16-1. The sum of the Feedforward Signal and the internal Demand Signal control(s) the output(s) of the controller. The feedforward source either increases or decreases the output of the controller to compensate, for example, an increased load amount that will be added to the process load.

13. GLOSSARY FOR SETPOINT OPTIONS

Tuning Constants The Setup Mode Tuning Constants shown on Figure 12-2.

Control Actions The Tuning Constants of P.B. (Proportional Band), RESET and RATE.

2nd Set of Control Actions P.B. (Proportional Band), RESET, and RATE shown to the right of bracket 2 in Figure 12-2. The SET. PT. Adjustment in the same bracket is the 2nd Setpoint.

Reset Inhibition The RESET Control Action is overridden and considered to be zero.

4 Vdc OUT A 4 Vdc source that can be used for powering external devices, especially external setpoint potentiometers.

Feedforward IN An external voltage input to the controller that shifts the proportional band with respect to the setpoint. Can be thought of as a remote manual reset or load lineout adjustment. If the Feedforward IN signal is at the 1 V minimum for a 1 to 5 Vdc signal, then the proportional band will not shift. If the Feedforward IN signal is at the 5 V maximum for a 1 to 5 Vdc signal, then the proportional band will shift 100%.

SETPOINT IN An incoming voltage setpoint signal, typically from either a UP55 Programmer, an 847A Programmer, or another 560 Controller. This incoming setpoint signal must be linear.

14. CONTROLLER SETPOINT OPTION 2

Controller Option 2 has an internal setpoint. There is no Setpoint & Analog Interface Signals Card in the 560 when Setpoint Option 2 is specified.

Operation is described in Section 18.

Controller Setpoint Option 2 Displays
(Either Display Option 1, 2 or 3)

For Either Display Options 1 or 2 When Controller is in the RUN Mode, Top Display indicates Process Signal. When the SETPOINT Key is depressed, Top Display indicates Setpoint.

There is no bottom display. Setpoint Light 1 is ON when power is turned on.

For Display Option 3 Top Display indicates Process Signal. Bottom Display indicates Setpoint Signal.

Setpoint Light 1 is ON when power is turned on.

15. CONTROLLER SETPOINT OPTION 4, WIRING AND OPERATION

15.1 Introduction

Setpoint Option 4 includes the REM/LOCAL Key, a second set of Proportional, Reset, and Rate Actions; Remote Reset Inhibition, 4 Vdc Out, Feedforward In, Setpoint In, Setpoint Out, and Process Out.

Figure 15-2 shows operation of the REM/LOCAL Key.

15.2 Jumper Placement

Controller is shipped jumpered for a span of 1-5 Vdc. Figure 12-1 shows the location of the SPAN Jumper. These spans are so programmed into the 560 Series Memory that they automatically correspond to the span of the input range of the controller.

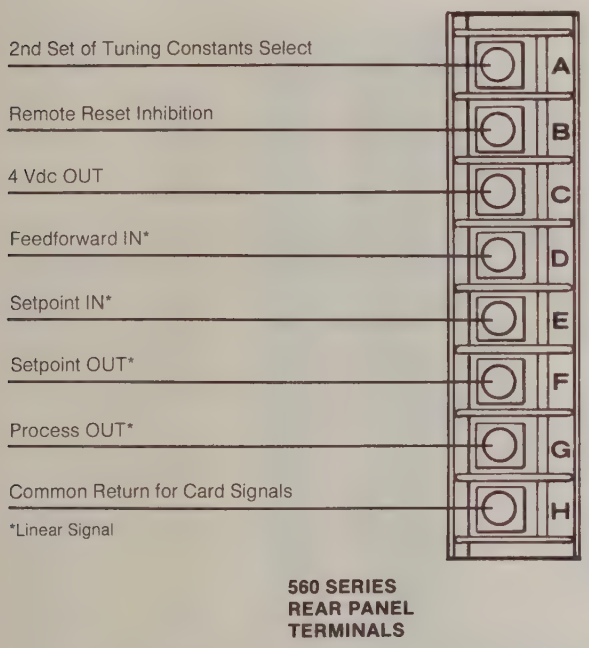


Figure 15-1. Controller Setpoint Option 4 Wiring

15.3 Wiring, Setpoint Option 4

See Figure 15-1.

Terminal A Wiring 2nd Tuning Constant Select. Contact closure to terminal H causes the controller to utilize the second set of Tuning Constants (Proportional, Reset, and Rate Actions). Maximum open circuit voltage: 20 Vdc to terminal H. Maximum short circuit current: 4 mAdc.

Terminal B Wiring Remote Reset Inhibition. Contact closure to H turns off internal reset.

Terminal C Wiring 4 Vdc supply, 4 mAdc maximum current. Can be used to drive an external programming slidewire which will produce a 0-4 Vdc signal that can be used as a remote setpoint signal to the 560.

Terminal D Wiring Feedforward IN. 1-5 Vdc* between terminal D and H. Input impedance: 500 k. The sum of the Feedforward signal and the internal Demand signal control(s) the output(s) of the controller.

Terminal E Wiring Setpoint IN. The Setpoint IN signal is 1-5 Vdc* between terminals E and H. Input impedance: 500 k.

Terminal F Wiring Setpoint OUT. The Setpoint OUT signal is 1-5 Vdc* between terminals F and H, proportional to the controller's span. Short circuit has no effect on control action. Maximum output: 2.5 mAdc.

Terminal G Wiring Process OUT Signal. The Process OUT signal is 1-5 Vdc* between terminals G and H. An external short circuit has no effect on control action. Maximum output: 2.5 mAdc.

Terminal H Wiring Common return for card signals.

*Changeable to 0-4 Vdc. See Table 15-1.

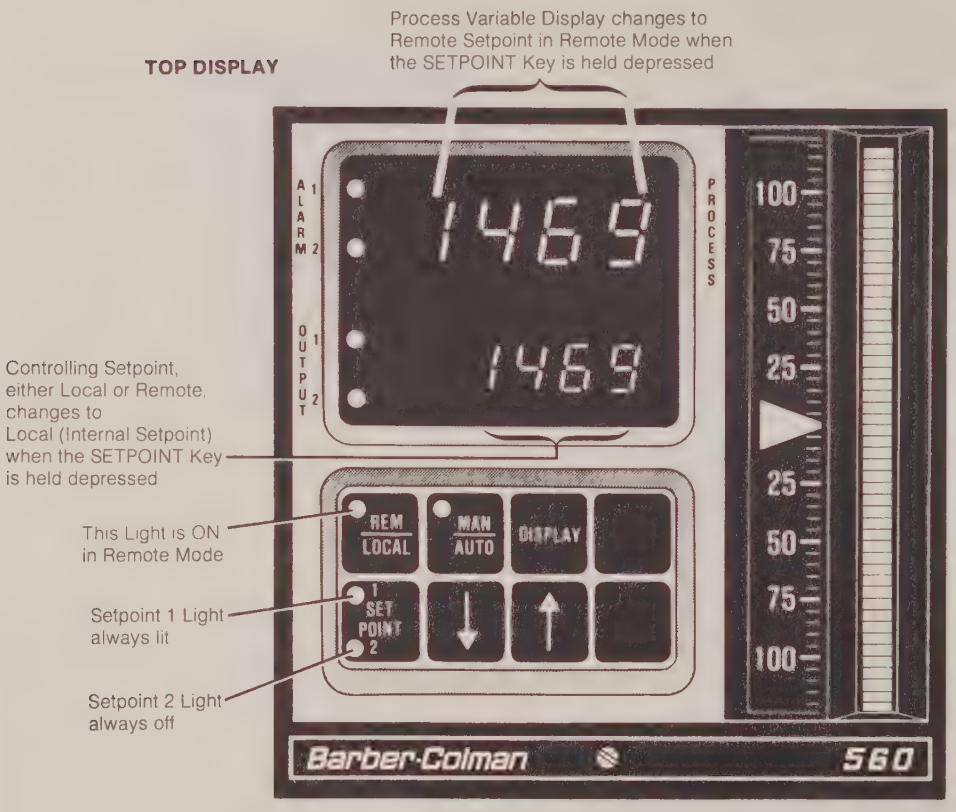
Table 15-1. TRIM, SP, and SPAN Jumper Placement for Option 4

Jumper	Jumper Position	Description of Action Caused
TRIM	IN	—
TRIM	OUT*	Trim Disabled (leave in this position)
SP	CONT*	Setpoint OUT is either the local or remote setpoint
SP	INT	Setpoint OUT is local setpoint
SPAN	0-4	0-4 Vdc Span selected for the Feedforward IN, Setpoint IN, Setpoint OUT, and Process OUT Signals
SPAN	1-5*	1-5 Vdc Span selected for the Feedforward IN, Setpoint IN, Setpoint OUT, and Process OUT Signals

*Shipped in this position.

Table 15-2. Controller Setpoint Option 4 Displays

	RUN Mode	SETPOINT Key depressed and in the RUN Mode
Top Display	Process Signal Indicated	Remote Setpoint IN Indicated
Bottom Display	Indicates the controlling setpoint, either Local (Internal) or Remote (External)	Internal Local Setpoint Indicated


TOP DISPLAY
Process Variable Display changes to Remote Setpoint in Remote Mode when the SETPOINT Key is held depressed
1469
1469
ALARM 1 2
OUTPUT 1 2
PROCESS
100 75 50 25 25 50 75 100
Controlling Setpoint, either Local or Remote, changes to Local (Internal Setpoint) when the SETPOINT Key is held depressed
This Light is ON in Remote Mode
Setpoint 1 Light always lit
Setpoint 2 Light always off
REM LOCAL
MAN AUTO
DISPLAY
1 SET POINT 2
Barber-Colman
560

Pressing the REM/LOCAL Key causes immediate transfer of the setpoint from LOCAL (internal) control to REMOTE (external) control. Remote Setpoint IN is on rear terminals E and H from a setpoint source such as the UP55 Programmer.

Figure 15-2. Display Action with Setpoint Option 4

16. CONTROLLER SETPOINT OPTION 5, WIRING AND OPERATION

16.1 Introduction

Controller Setpoint Option 5 includes a 2nd Set of Tuning Constants (Proportional, Reset, and Rate Actions), Remote Reset Inhibition, 4 Vdc Out, Feedforward In, Setpoint In, Setpoint Out and Process Out.

Table 16-1 gives specific instructions on card jumper placement for Option 5.

Figure 16-2 shows the display action for Setpoint Option 5.

Trim Setpoint is the main feature of Option 5. The 560 Controller is used as a slave controller on the zone of a furnace or an extruder. The 1-5 Vdc setpoint voltage on the Setpoint IN Terminal E from an external source can be trimmed by controller adjustments. Setpoint IN source can be either a Master Controller, a Programmer, or a computer. Input impedance is 1 M ohms. ±511 counts can be added to the Remote Setpoint IN voltage.

If the Remote Setpoint is 1000°F, the trim can change the setpoint from 489°F (1000 - 511) to 1511°F (1000 + 511).

If the Remote Setpoint is 100.0°F, the trim can change the setpoint from 48.9°F to 151.1°F.

Figure 12-1 shows location of SPAN Jumper. These spans are so programmed in the 560 Series Memory that they automatically correspond to the span of the input range of the controller.

16.2 Wiring of Option 5

See Figure 16-1.

Terminal A Wiring 2nd Tuning Constant Select. Contact closure to terminal H causes the controller to utilize the second set of Tuning Constants (Proportional, Reset, and Rate Actions). Maximum open circuit voltage: 20 Vdc to terminal H. Maximum short circuit current: 4 mAdc.

Terminal B Wiring Remote Reset Inhibition. Contact closure to H turns off internal reset.

Terminal C Wiring 4 Vdc supply, 4 mAdc maximum current. Can be used to drive an external programming slidewire which will produce a 0-4 Vdc signal that can be used as a remote setpoint signal to the 560.

Terminal D Wiring Feedforward IN. 1-5 Vdc* between terminal D and H. Input impedance: 500 k. The sum of the Feedforward signal and the internal Demand signal control(s) the output(s) of the controller.

Terminal E Wiring Setpoint IN. The Setpoint IN signal is 1-5 Vdc* between terminals E and H. Input impedance: 500 k.

Terminal F Wiring Setpoint OUT. The Setpoint OUT signal is 1-5 Vdc* between terminals F and H, proportional to the controller's span. Short circuit has no effect on control action. Maximum output: 2.5 mAdc.

Terminal G Wiring Process OUT Signal. The Process OUT signal is 1-5 Vdc* between terminals G and H. An external short circuit has no effect on control action. Maximum output: 2.5 mAdc.

Terminal H Wiring Common return for card signals.

*Changeable to 0-4 Vdc. See Table 16-1.

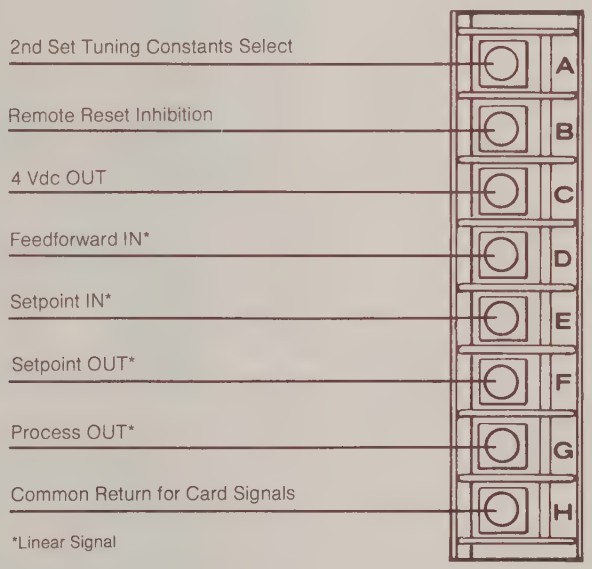


Figure 16-1. Controller Setpoint Option 5 Wiring

Table 16-1. TRIM, SP, and SPAN Jumper Placement for Setpoint Option 5

Jumper	Jumper Position	Description of Action Caused
TRIM	IN*	Trim Enabled (leave in this position)
TRIM	OUT	—
SP	CONT*	Setpoint OUT is sum of Trim and Remote Setpoint IN
SP	INT	Setpoint OUT is Trim Setpoint (−511 = 0%; +511 = 100%)
SPAN	0-4	0-4 Vdc Span selected for the Feedforward IN, Setpoint IN, Setpoint OUT, and Process OUT Signals
SPAN	1-5*	1-5 Vdc Span selected for the Feedforward IN, Setpoint IN, Setpoint OUT, and Process OUT Signals

*Shipped in this position.

16.3 Trim Setpoint Adjustment

With Option 5 which has Trim as its major feature,

* 560 Controller is always in the Remote Mode.
* Trim can add ±511 counts to the Remote Setpoint IN.

CONTROLLING SETPOINT = TRIM SETPOINT + REMOTE SETPOINT IN

The Controlling Setpoint is shown on the bottom display of Figure 16-2.

To adjust the Trim Setpoint, the Controller must be in the RUN Mode. Now hold down the

[SET POINT] Key

You must hold the SETPOINT Key down; otherwise, the controller displays will return to the displays shown on Figure 16-4.

While holding the SETPOINT Key down, adjust the Trim Setpoint by means of the

[▲] and [▼] Keys

This is a general procedure. A specific example is given in Paragraph 16.4, which follows this paragraph.

* 560 Controller always in the Remote Mode.
* Trim can add ±511 counts to the Remote Setpoint IN Signal.

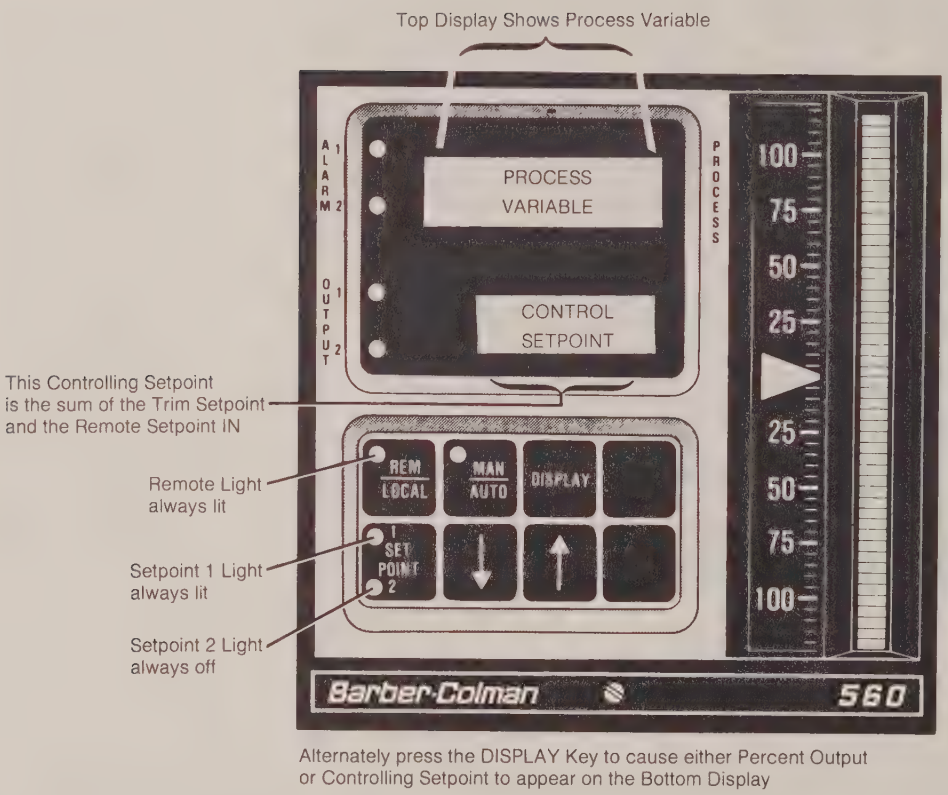


Figure 16-2. Controlling Setpoint, Sum of Trim and the Remote Setpoint IN

Table 16-2. Controller Setpoint Option 5 Displays

	RUN Mode	SETPOINT Key depressed and in the RUN Mode
Top Display	Process Signal Indicated	Remote Setpoint IN Indicated
Bottom Display	Indicates the Controlling Setpoint, which is the sum of the Trim and Remote Setpoints	Trim Setpoint Indicated

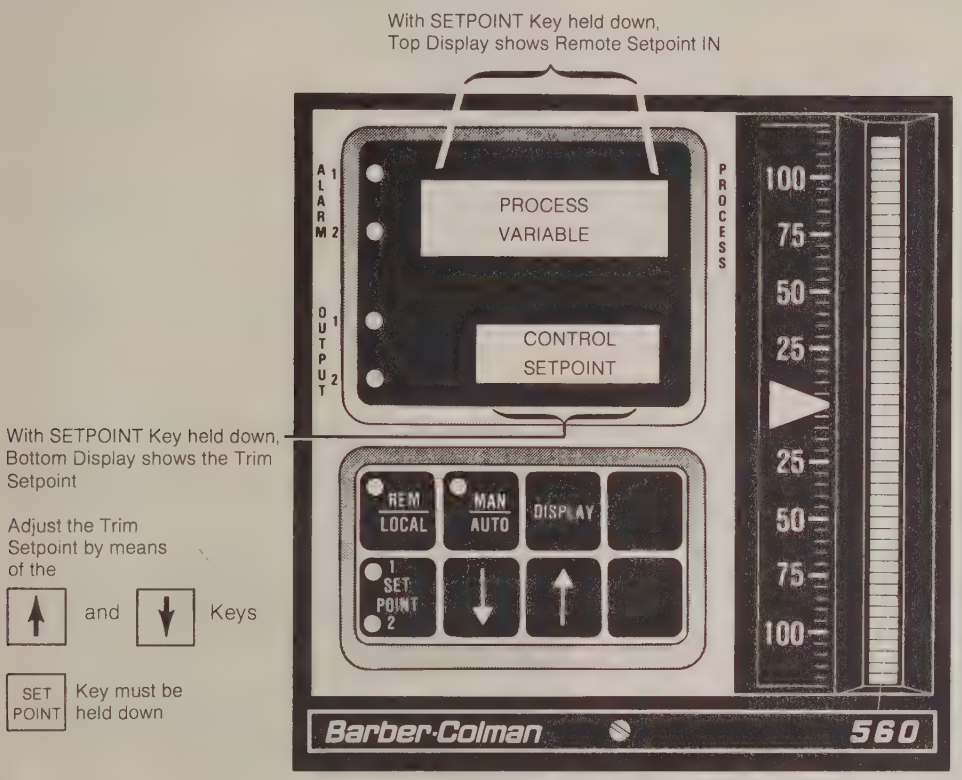


Figure 16-3. Adjusting Trim Setpoint

16.4 Example of Adjusting Trim Setpoint

See Figures 16-3 and 16-4.

Thermocouple Range is 0-4200°F. The Setpoint IN Signal of 1-5 Vdc corresponds exactly to the thermocouple range. That is, 0°F corresponds to 1 Vdc, and 4200°F corresponds to 5 Vdc.

Controller is in the Remote Mode.

Display Example in the RUN Mode is this:

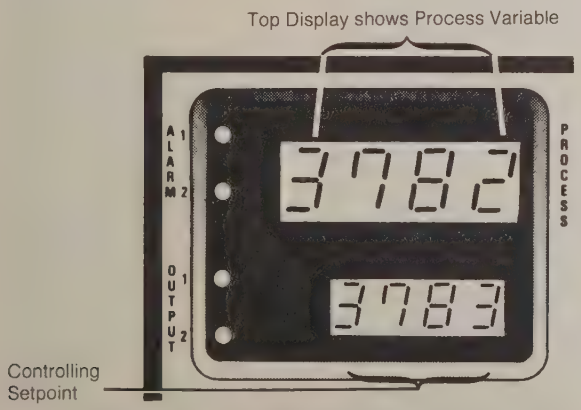


Figure 16-4. Run Mode Display Example

You want the Controlling Setpoint **to be** 3945, **not** 3783.

Write down the Controlling Setpoint of 3783.

To adjust the Trim Setpoint the controller must be in the RUN Mode. Hold down the

SET POINT Key

You must continue to hold down the SETPOINT Key; otherwise, the controller displays will return to the display shown on Figure 16-4.

and you get this display:

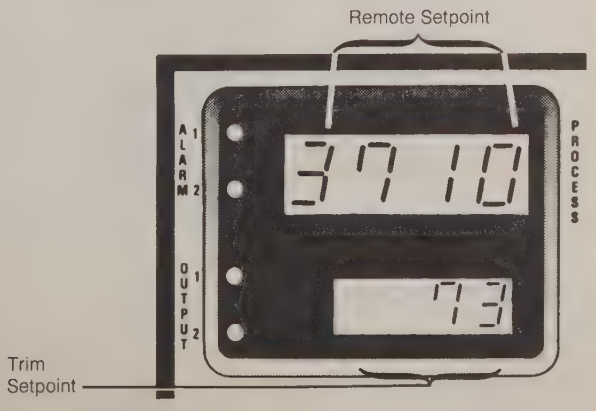


Figure 16-5. Trim Mode Display Example

The sum of this (3710 + 73 = 3783) is the present Controlling Setpoint; but, you want to change to a controlling setpoint of 3945 by changing the Trim Setpoint.

The formula is

CONTROLLING SETPOINT = TRIM SETPOINT + REMOTE SETPOINT IN

Substituting in this formula

3945 = Trim Setpoint + 3710

So, the new Trim Setpoint is 235.

Continue to hold the SETPOINT Key down.

See Figure 13-7 and adjust the Trim Setpoint by means of the INCREASE and DECREASE Keys, until it is equal to 235.

The display should now be this.

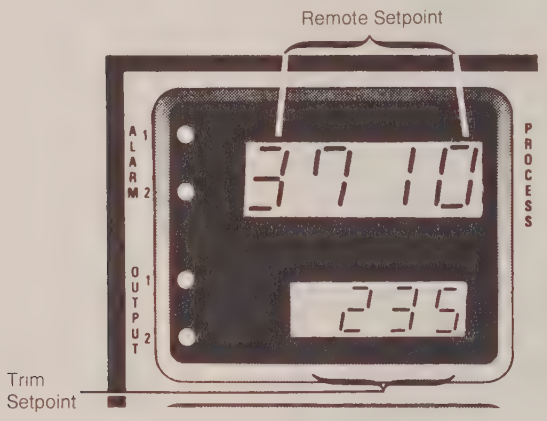


Figure 16-6. Adjusted Trim Display

Now release the SETPOINT Key.

The Controller Displays should look like this.

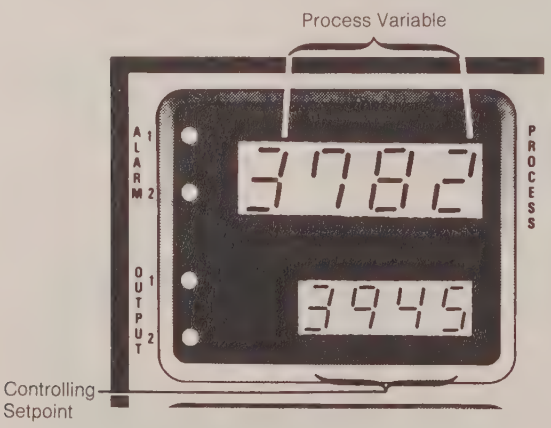


Figure 16-7. Adjusted Controller Setpoint Display

Procedure is now completed.

17. CONTROLLER SETPOINT OPTION 6, WIRING AND OPERATION

17.1 Introduction

Option 6 includes Remote Reset Inhibition. There are two internal setpoints and two sets of Tuning Constants (Proportional Band, Rate, and Reset Control Actions).

This option meets those critical process heating furnace needs for dual control action. The operator can switch the Controller from one preadjusted set of Setpoint, Proportional Band, Reset, and Rate to another preadjusted set.

When terminal A is shorted to terminal H, control switches from the 1st set of Tuning Constants to the 2nd set; and, from the 1st Setpoint to the 2nd Setpoint.

17.2 Wiring of Option 6

Terminal A Wiring 2nd Setpoint and 2nd Set of Tuning Constants.
Maximum open circuit voltage: 20 Vdc to terminal H.
Maximum short circuit current: 4 mAdc.

Terminal B Wiring Remote Reset Inhibition. Contact closure to terminal H turns internal reset off.

Terminal H Wiring Common return for card signals.

17.3 Setpoint Option 6 Operation with Display Options 1 and 2

Figures 17-2 and 17-3 show all operations.

17.4 Setpoint Option 6 Operation with Display Option 3

Figures 17-2 and 17-4 show all operations.

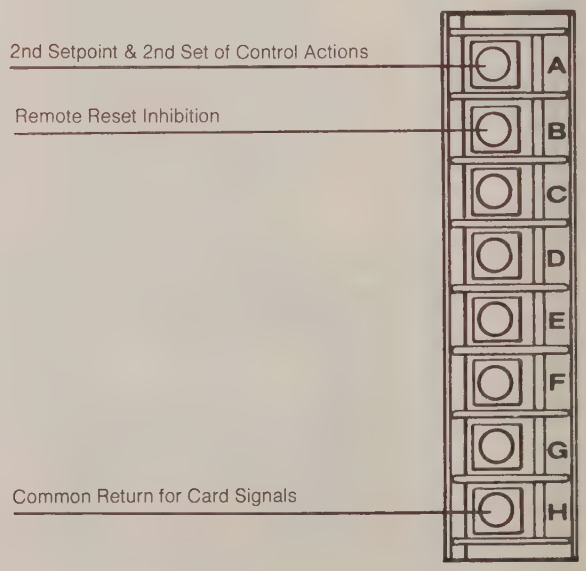


Figure 17-1. Controller Setpoint Option 6 Wiring

17.5 Second Setpoint Adjustment

The Second Setpoint in Option 6 is adjusted in the same manner as a Tuning Constant. Paragraph 18.4, Setup Mode, describes in general how to change Tuning Constants.

The following step procedure details how to change the 2nd Setpoint for Option 6.

1. Press the SETUP Key just once. Four dashes (----) replace the numeric value in the top display, indicating that the controller is ready for you to proceed.

   At the same time, the bar display disappears, leaving only the bottom segment and a single segment lit below MAN RESET. This segment is a cursor to identify the Tuning Constants available for adjustment.

2. To move the cursor upward, hold the SETPOINT Key in and momentarily press the SETUP Key. The cursor will now jump up to the first Tuning Constant.

   The top display will now show the present value of the identified Tuning Constant.

   The cursor will skip any Tuning Constant that is not a feature of the Controller.

3. Continue to hold the SETPOINT Key in and repeatedly press the SETUP Key until the cursor is opposite the marking: 2 SET. PT. (Second Setpoint).

4. The 2nd Setpoint can be either raised or lowered by pressing either the INCREASE or DECREASE Key.

   The longer the INCREASE or DECREASE Key is held down, the faster the setpoint will change. To slow the rate of change, simply release the key and press it again.

5. Go to the RUN Mode by pressing the SETUP Key just once.

6. Deliberately exiting the SETUP Mode by pressing the SETUP Key or advancing the cursor causes the currently displayed value of the 2nd Setpoint to be loaded in permanent memory, replacing the previous value. If no keys are operated for approximately 1.5 minutes, the controller will automatically return to the RUN Mode, but will revert to the previously stored value of the 2nd Setpoint displayed at that time.

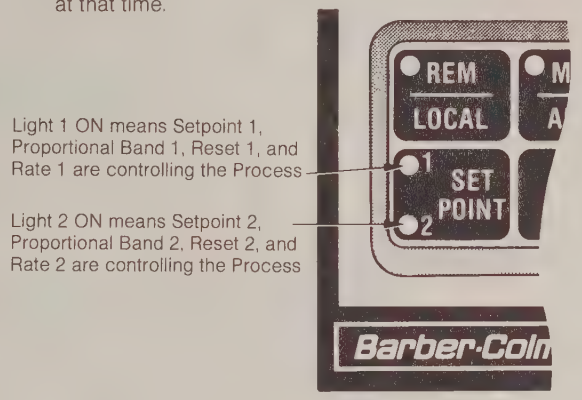
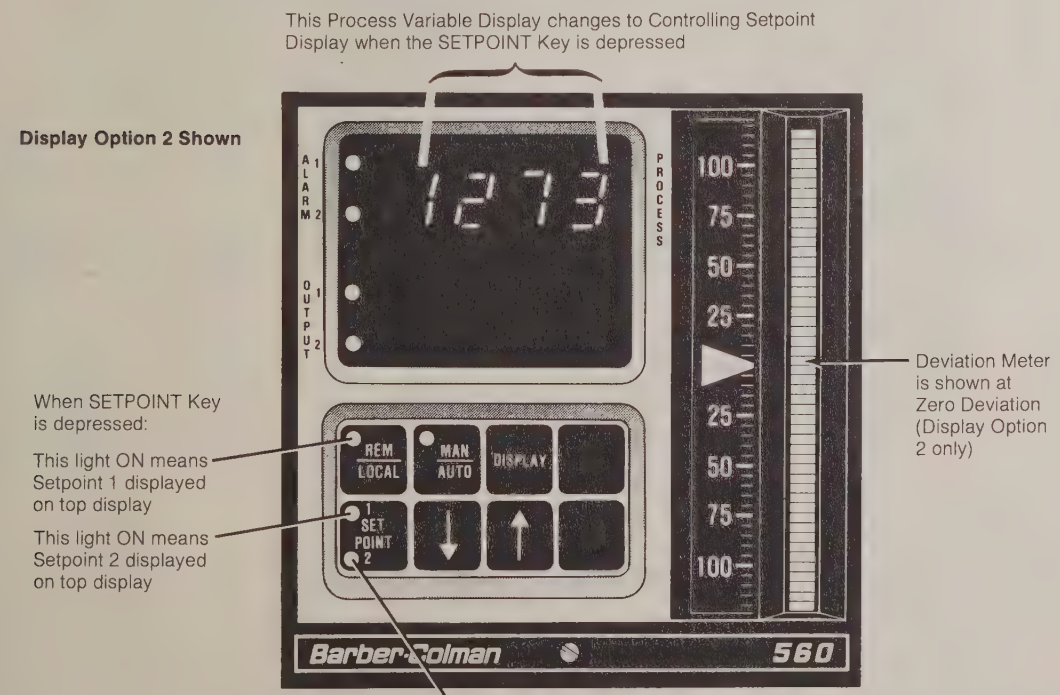
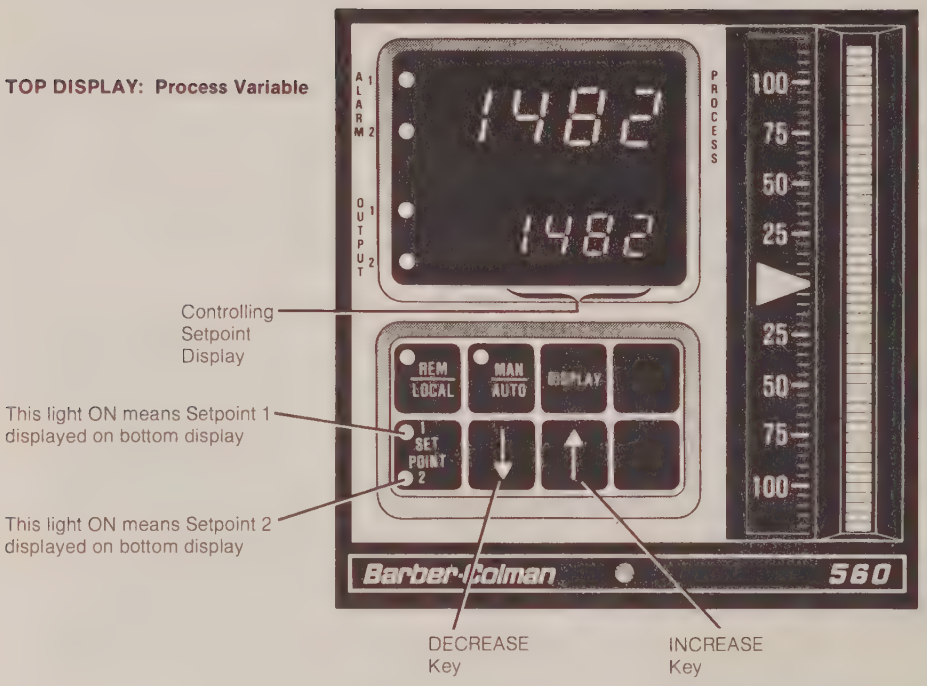

Light 1 ON means Setpoint 1, Proportional Band 1, Reset 1, and Rate 1 are controlling the Process
Light 2 ON means Setpoint 2, Proportional Band 2, Reset 2, and Rate 2 are controlling the Process
REM
LOCAL
SET POINT
Barber-Coln

Figure 17-2. Setpoint Lights, Option 6


This Process Variable Display changes to Controlling Setpoint Display when the SETPOINT Key is depressed
Display Option 2 Shown
When SETPOINT Key is depressed:
This light ON means Setpoint 1 displayed on top display
This light ON means Setpoint 2 displayed on top display
Deviation Meter is shown at Zero Deviation (Display Option 2 only)
Pressing the SETPOINT Key causes the Controlling Digital Setpoint to be displayed — replacing the Digital Process Signal
ALARM
OUTPUT
PROCESS
100
75
50
25
REM LOCAL
MAN AUTO
DISPLAY
SET POINT
Barber-Colman
560

Setpoint Light ON	Setpoint Displayed on Top Display	Control Action Set Controlling Process
1	1st	1st Set
2	2nd	2nd Set

Figure 17-3. Display Options 1 and 2 Actions with Setpoint Option 6



Setpoint Light ON	Setpoint Displayed on Bottom Display	Control Action Set Controlling Process
1	1st	1st Set
2	2nd	2nd Set

Figure 17-4. Display Option 3 Action with Setpoint Option 6

18. SETUP PROCEDURE AND DISPLAY OPTIONS

18.1 Introduction

The Series 560 Controller is available with three different display options:

OPTION 1 = Digital Process Meter with Setpoint Display on Command

2 = Option 1 and Deviation LED Bar

3 = Option 2 and a Second Digital Meter for both Setpoint and % Output

The digit 1, 2 or 3 appears as the tenth digit in the Model Number (56XX-XXXXX-**X**XX-X-XX).

18.2 Setpoint, Process and % Output Displays

On Display Options 1 (see Figure 18-1) and 2 (see Figure 18-2) pressing the SETPOINT Key causes the setpoint to be displayed in place of the process variable (temperature, mV, etc.). When the SETPOINT Key is released, the process variable will again be displayed.

On Display Option 3 (see Figure 18-3) separate displays are provided for the process variable and the setpoint. The setpoint display can be replaced by a % output display by pressing the DISPLAY key (except in ON-OFF Control Mode). The % output variable is always displayed with a dash before and after the readout (i.e., -50-). Pressing the DISPLAY key again will cause the setpoint to be displayed instead of the % output.

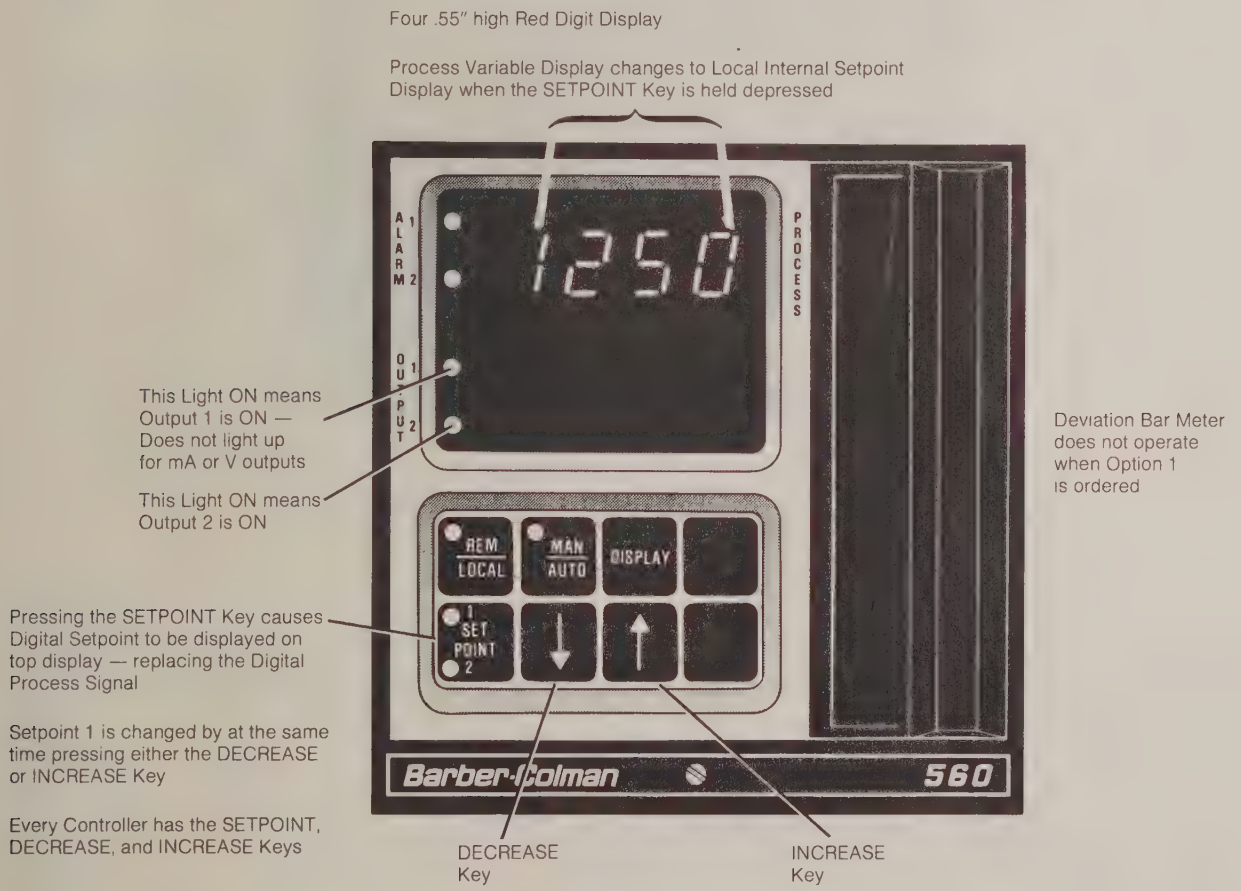

Four .55" high Red Digit Display
Process Variable Display changes to Local Internal Setpoint Display when the SETPOINT Key is held depressed
1250
ALARM 1 2
OUTPUT 1 2
PROCESS
This Light ON means Output 1 is ON — Does not light up for mA or V outputs
This Light ON means Output 2 is ON
Deviation Bar Meter does not operate when Option 1 is ordered
REM LOCAL
MAN AUTO
DISPLAY
1 SET POINT 2
Pressing the SETPOINT Key causes Digital Setpoint to be displayed on top display — replacing the Digital Process Signal
Setpoint 1 is changed by at the same time pressing either the DECREASE or INCREASE Key
Every Controller has the SETPOINT, DECREASE, and INCREASE Keys
Barber-Colman
560
DECREASE Key
INCREASE Key

Figure 18-1. Display Option 1: Digital Process Meter with Display Setpoint on Command

Four .55" high Red Digit Display
Process Variable Display changes to Local Internal Setpoint Display when the SETPOINT Key is held depressed
Deviation Bar Calibration Option 4 shown
1250
ALARM 1 2
OUTPUT 1 2
PROCESS
100 75 50 25 25 50 75 100
REM LOCAL
MAN AUTO
DISPLAY
SET POINT 1 2
Barber-Colman
560
DEVIATION BAR has red segments that mark deviation from setpoint in the RUN Mode
This figure shows zero deviation
DECREASE Key
INCREASE Key
49 Red Segment Bars Lowest Bar is always lit
Pressing the SETPOINT Key causes Digital Setpoint to be displayed on top display — replacing the Digital Process Signal
Setpoint 1 is changed by at the same time pressing either the DECREASE or INCREASE Key
Every Controller has the SETPOINT, DECREASE, and INCREASE Keys

Figure 18-2. Display Option 2: Digital Process Meter and Deviation Bar Meter

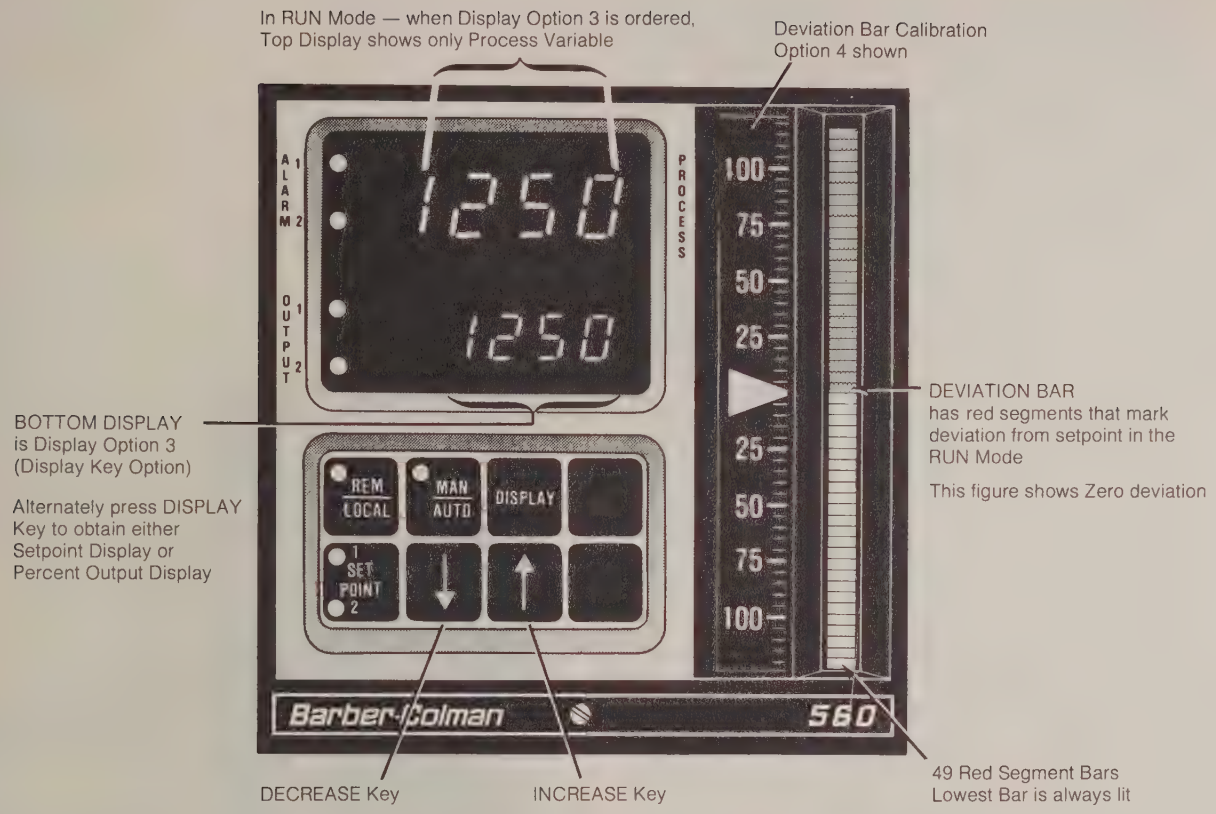

In RUN Mode — when Display Option 3 is ordered, Top Display shows only Process Variable
Deviation Bar Calibration Option 4 shown
1250
1250
ALARM 1 2
OUTPUT 1 2
PROCESS
100
75
50
25
25
50
75
100
REM LOCAL
MAN AUTO
DISPLAY
1 SET POINT 2
Barber-Colman
560
BOTTOM DISPLAY is Display Option 3 (Display Key Option)
Alternately press DISPLAY Key to obtain either Setpoint Display or Percent Output Display
DEVIATION BAR has red segments that mark deviation from setpoint in the RUN Mode
This figure shows Zero deviation
DECREASE Key
INCREASE Key
49 Red Segment Bars Lowest Bar is always lit
Setpoint 1 is changed by pressing the SETPOINT Key Card and at the same time pressing either the DECREASE or INCREASE Key
Every Controller has the SETPOINT, DECREASE, and INCREASE Keys

Figure 18-3. Display Option 3: Digital Process Meter, Deviation Bar Meter, and a Second Digital Meter for Setpoint and Percent Output

18.3 Changing the Setpoint

There are two different procedures for changing the setpoint, depending on the position of the LOCK Jumper. This jumper is located to the left of the INPUT SELECT Pins, at the right rear corner of the Main Board. See Figure 18-4.

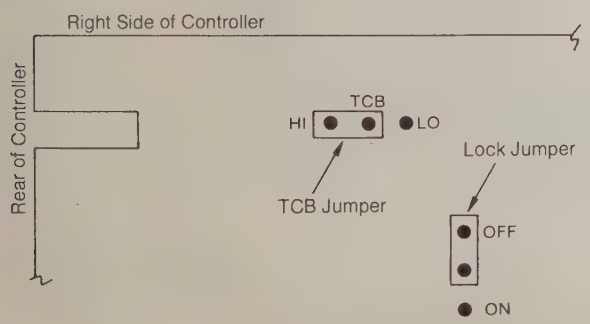


Figure 18-4. Lock Jumper Location

If the Jumper is placed across the middle pin and the pin next to the word ON, the setpoint is in the LOCKED Setpoint mode. This means that anytime the setpoint is changed, the operator must go through the following procedure.

1. Press the SETPOINT Key.
2. Release the SETPOINT Key and, within one second, press the DISPLAY Key.
3. Release the DISPLAY Key and press and hold the SETPOINT Key.
4. Now the setpoint may be either raised or lowered by pressing either the INCREASE or DECREASE Key, while continuing to hold down the SETPOINT Key. The longer the INCREASE or DECREASE Key is held down, the faster the setpoint will change. To slow the rate of change, simply release the key and press it again.

This procedure can be used to prevent unauthorized changes of the setpoint. The setpoint will automatically lock up again about 1.6 minutes after the last key is depressed.

If the jumper is placed across the middle pin and the pin next to C15, the setpoint is in the Regular Setpoint Mode. To change the setpoint, the operator must:

1. Hold down the SETPOINT Key.
2. Press either the INCREASE or DECREASE Key while continuing to hold down the SETPOINT Key, to change the setpoint.

18.4 Setup Mode

When the controller is in the SETUP mode, the displays are altered to enable the operator to review and alter tuning constants and alarm setpoints. Control action continues undisturbed, except for the normal consequences of any parameter changes made.

A small notch on the access door near the deviation scale index allows the door to be opened with a fingernail or small tool, exposing a calibration jack, the SETUP key and logo used to identify parameters for review or alteration. To adjust tuning constants:

1. Press SETUP key once. Four dashes will replace the numeric value in the top display, indicating that the controller is ready for you to proceed. At the same time, the bar display will disappear, leaving only the bottom segment and a single segment just below "MAN RESET" lit. This segment acts as a cursor to identify parameters available for adjustment.
2. To advance the cursor, hold the SETPOINT key in and momentarily press the SETUP key. The cursor will then jump up to the first parameter. The top display will now show the present value of the identified parameter
3. This value may be incremented through its available range by using the INCREASE and DECREASE keys. If this was the only parameter you wished to change, exit the SETUP mode by pressing SETUP To proceed to examine or change other parameters, advance the cursor by repeating the SETPOINT SETUP sequence described above.

NOTE: Deliberately exiting the SETUP mode or advancing the cursor causes the currently displayed value of a parameter to be loaded in permanent memory, replacing the previous value. If no keys are operated for approximately 1.5 minutes, the controller will automatically return to the RUN mode, but will revert to the previously stored value of the parameter indexed at that time.

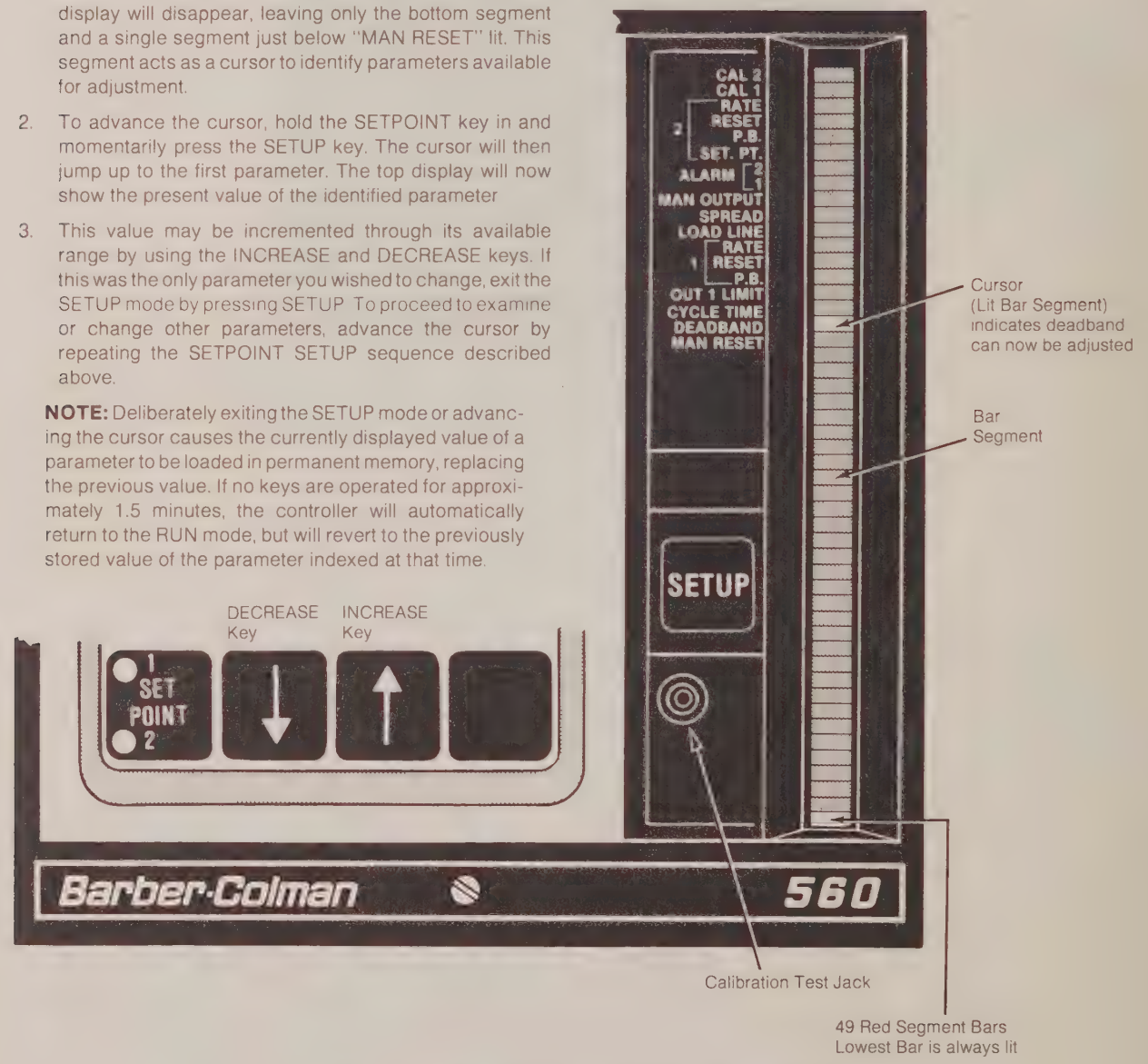


Figure 18-5. Basic Keyboard Functions in SETUP Mode

18.5 SETUP Mode — Changing the Alarm Setpoints

Alarm setpoints can be changed using the same procedure that was used in Paragraph 18.4. It is important that the individual adjusting the controller knows the alarm configuration on the controller. This information is found by taking the 13th digit of the Model Number (56XX-XXXXX-XXX-**X**-XX). See Paragraph 7.3 to calculate alarm setpoints.

18.6 MAN/AUTO Key

This option provides bumpless and balanceless transfer from Auto to Manual to Auto Control. When transferring from Auto to Manual, the output of the 560 remains at the last value it had while in the Auto Mode. The output may then be changed by pressing either the INCREASE Key or the DECREASE Key. When transferring from Manual to Auto, the output will do one of the following two things:

1. If RESET = .00 then the output will jump from the last value it had in the Manual Mode to the controller calculated output value in the PD Mode. In this case the transfer is not bumpless.
2. If RESET ≠ .00 then the output will ramp from the last value it had in the Manual Mode to the controller calculated value in the Auto Mode. The rate at which the output ramps is a factor of the RESET value. The lower the RESET value, the smoother and longer the ramp will take.

If the setpoint's lock jumper is in the ON position (see Figure 18-4), do the following procedure to toggle the MAN/AUTO Key:

1. Press the SETPOINT Key.
2. Release the SETPOINT Key and within one second, press the DISPLAY Key. This unlocks the keyboard.
3. Release the DISPLAY Key and press the MAN/AUTO Key.

If the setpoint lock jumper is NOT in the ON position, simply pressing the AUTO/MAN Key will cause it to toggle.

18.7 REM/LOCAL Key

This option allows the controller to select an external setpoint or its own internal setpoint. This key will be operative on all controllers with the Remote-Local Setpoint and Trim Setpoint Options. If the controller's lock jumper is in the ON position, the REM/LOCAL Key is toggled by the following procedure:

1. Press the SETPOINT Key.
2. Release the SETPOINT Key and within one second press the DISPLAY Key. This unlocks the keyboard.
3. Release the DISPLAY Key and press the REM/LOCAL Key. If the controller's lock jumper is not in the ON position, simply pressing the REM/LOCAL Key will cause it to toggle.

19. TUNING THE CONTROLLER

19.1 Introduction

The following procedures give initial settings which can be used as a starting point for tuning the controller to match the process.

19.2 On-Off Controller (Model 561X-XXXXX-XXX-X-XX)

1. Set DEADBAND = .25%.
2. Adjust the setpoint to the desired value.
3. Allow plenty of time for the process variable to stabilize.
4. If undue cycling occurs, increasing the Deadband to the next level may improve control.
5. To test the effects of change in Deadband, change the setpoint by 5% of span in either direction.
6. Repeat Steps 3-5 until the ultimate value for Deadband is found.

19.3 Proportional Controller with Reset and Rate (564X and 565X-XXXXX-XXX-X-XX)

1. Set P.B. (1) = 50%.
2. Set RESET (1) = 0.
3. Set RATE (1) = 0.
4. Set LOAD LINE = 50%.
5. Adjust the setpoint to the desired value.
6. Allow plenty of time for the process variable to stabilize.
7. a. If the process variable is stable, decrease the P.B. (1) setting until instability is reached. After the process becomes unstable, increase the P.B. (1) setting slightly.

   b. If the process variable is unstable, increase the P.B. (1) setting until the process variable becomes stable.
8. After each change in the P.B. (1) setting, the setpoint should be shifted 5% of span in either direction.
9. Repeat Steps 6-8 until the ultimate value for P.B. (1) is found.
10. Set RESET (1) = 1.
11. Wait 2 to 5 minutes.

    a. If the process is stable, increase RESET (1) in small increments until the process oscillates. Then slightly decrease RESET (1) until the oscillations cease.

    b. If the process is unstable, decrease RESET (1) in small increments until the oscillations cease. Wait for the process to settle down after each adjustment.
12. Introduce a setpoint change of 5% of span. For best results, the process response should be observed on a recorder. This allows observation of overshoots and settling times.

    a. If more overshoot occurs than can be tolerated, slightly increase the P.B. (1) setting. If more than two adjustments are necessary, it may be preferable to slightly decrease the RESET (1) setting than to continue to widen the proportional band.

    b. If there is no overshoot, the time required to reach the new equilibrium may be excessive. It can be reduced by decreasing the P.B. (1) setting in small increments until a single, small overshoot occurs in response to a setpoint change. Such a setting is usually preferred, as settling time is minimal. If more than three steps

are required to obtain an overshoot, it may be preferable to increase the RESET (1) setting in small increments than to further widen the proportional band.

13. Set RATE = .5.
14. Introduce a setpoint change of 5% of span. Wait for the system to settle down.
    a. If the process remains stable, slightly increase the RATE (1) setting. Make another 5% setpoint change in the other direction. Repeat this procedure until a rate setting is found which will cause oscillations. When this setting is found, reduce the setting until oscillations no longer occur with a setpoint change.
    b. If the process oscillates due to a setpoint change, slightly decrease the RATE setting. Check the new setting by making another step change. Repeat until a setting is found where the process will not oscillate with a setpoint change.

19.4 Cycle Time Adjustment (562E-E or 564E-EXXXX-XXX-X-XX; and 5621, 5641, 5622 or 5642-XXXXX-XXX-X-XX)

The CYCLE TIME control will change the cycle time from 1 to 64 seconds. The faster cycle rates on the order of 6 seconds per cycle provide better control of loads with fast response times and little time lag. However, a relatively faster cycle time causes added wear on an external contactor. Caution should be exercised when large mechanical contactors are driven by the controller.

19.5 Output 1 Limit Adjustment

The OUT 1 LIMIT control is usually set at 100%. It can be used to limit the % output of the controller if the process cannot tolerate full output. For example, a 4-20 mA output controller with OUT 1 LIMIT = 50 will never have an output above 12 mA. The OUT 1 LIMIT should not be set lower than 100% unless absolutely necessary.

19.6 Load Lineout Adjustment

The LOAD LINE is usually set at 50%. LOAD LINE is a manual reset superimposed on the automatic reset action to prevent offset. Adjusting the LOAD LINE control shifts the controller proportional band with respect to the setpoint. The LOAD LINE control is, in effect, a manual reset control preset for the type of furnace and load. It is set up as a percent of controller maximum output. The LOAD LINE control is set to reduce offset by observing the percent output required to control the process and then adjusting the LOAD LINE to that value. The LOAD LINE control can be adjusted to manually correct for any large step changes in load, but this is rarely done. Figure 19-1 shows the effect of three different LOAD LINE control settings on proportional band.

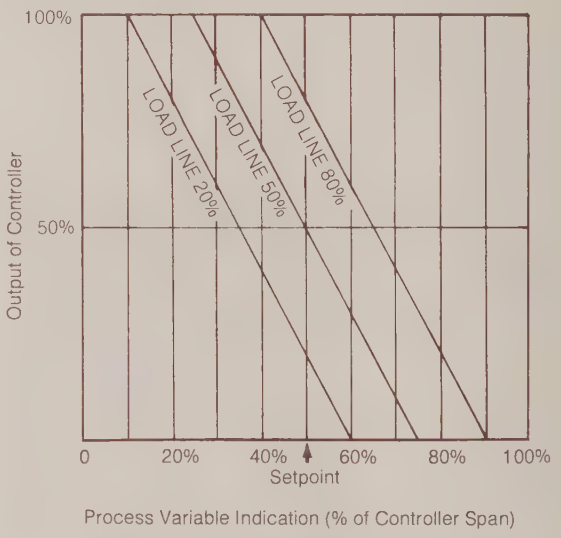


Figure 19-1. Load Lineout Effect on Proportional Band (PB = 50%)

19.7 Spread Adjustment (Models 56XX-1, 56XX-2 or 56XE-EXXXX-XXX-X-XX)

The SPREAD Control is used whenever the controller is supplied with two outputs. Output 1's setpoint is set by using the procedure in Section 9.3. Output 2's setpoint is set by using the SPREAD control. It can be set anywhere from -511 to +511 counts. For example, if Output 1's setpoint is set at 800°F, Output 2's setpoint can be set from 289°F to 1311°F. To set Output 2's setpoint at 289°F, set SPREAD = -511. To set it at 1311°F, set SPREAD = 511. Output 2 deadband is fixed at .5% of span.

20. MEMORY REFRESH AND CALIBRATION

MEMORY REFRESH

This instrument has an electronic memory which must be refreshed at least annually. Performing any of the calibration procedures listed below will automatically refresh the memory. If it is impractical to calibrate annually, refresh must still be accomplished by proceeding as follows:

1. **Press the SETUP Key once.**
2. **Hold the DISPLAY Key in and momentarily press the SETUP Key.**
3. **Release the DISPLAY Key.**
4. **Press the SETUP Key for one second or more. Do not interrupt power to the 560 for 20 seconds.**

All 560 Series Controllers are factory calibrated before shipment. Check calibration before operation and then yearly after that.

Table 20-1. Calibration Point Data for TL Range Codes 00X to 3XX

Range Code	CAL 1 Point	CAL 2 Point
009	200	200
010	150	150
011	300	300
012	400	400
013	150	150
015	600	600
016	800	800
017	1000	1000
018	1200	1200
019	1600	1600
020	1760	1760
021	300	300
022	400	400
023	200	200
024	600	600
025	800	800
027	600	600
028	600	600
029	1600	1600
030	2000	2000
031	2500	2500
032	800	800
033	1000	1000
034	1000	1000
035	1400	1400
036	3000	3000
037	1600	1600
038	3000	3000
039	2500	2500
040	1600	1600
041	2500	2500
042	1200	1200
043	1094	1094
044	3300	3300
045	1800	1800
046	854	854
100	2258	2258

Range Code	CAL 1 Point	CAL 2 Point
101	3020	3020
102	3000	3000
104	1800	1800
105	595	595
109	3475	3475
110	3402	3402
111	1760	1760
112	1848	1848
114	3608	3608
115	4053	4053
116	3000	3000
117	2208	2208
118	3608	3608
119	2048	2048
120	2970	2970
121	1600	1600
122	2990	2990
199	456	456
200	500	500
201	-130	-130
202	400	400
203	300	300
204	400	-138
205	400	400
206	700	700
207	200	200
208	100	100
209	400	400
210	100	100
211	300	300
212	200	200
213	400	400
250	2200	2200
251	1200	1200
252	2200	2200
253	1092	1092
254	1816	1816
256	1999	1999

20.1 Equipment

Thermocouple input calibration equipment:

- Millivolt Source.
- Calibration Cable Assembly 24-48.
- Temperature versus EMF Tables. Barber-Colman 1111 DB 10-1 or equivalent.
- Thermometer. Weston Dial Type or equivalent.

If other than a thermocouple input is used, an appropriate source and Process Variable versus Input Table must be used (for example, source and milliampere versus temperature table).

20.2 Calibration Data

Calibration point data for each thermocouple range is listed in Table 20-1. The following procedure uses Range Code 122 as an example. Specific values relating to the example range are in parenthesis throughout the Step Procedure in Paragraph 20.3.

The Range Code is the three digit number in the 7th, 8th and 9th digits of the Model Number. For this example, the Model Number is 56XX-XX122-XXX-X-XX.

Example Range

Range Code 122: 1000° to 3000°F.

Thermocouple Type: Tungsten, 3% Rhenium-Tungsten, 25% Rhenium.

From Table 20-1. Cal 1 = 2990 Cal 2 = 2990

The ambient temperature at the controller thermocouple input terminals is assumed to be 80°F.

20.3 Calibration Procedure for a Thermocouple Input (Range Codes 00X to 3XX)

Proceed as follows:

Step 1. Connect the Calibration Cable Assembly (positive lead has red insulation) to the millivolt source.

Step 2. Push Calibration Assembly Plug into the front panel Calibration Jack, which is just under the SETUP Key.

Step 3. Find the CAL 1 value for the controller's Range Code in Table 20-1 (2990°F for Range Code 122). If Range Code is not in Table 20-1, refer to the special range information sent with the manual.

Step 4. Adjust the millivolt source to the millivolt equivalent of the CAL 1 (30.140 mV in this example) value. The millivolt equivalent can be found either in Barber-Colman Data Bulletin 1111 DB 10-1 or National Bureau of Standards Monograph 125.

Step 5. Press the SETUP Key just once. Four dashes will replace the numeric value in the top display, indicating that the controller is ready for you to proceed. At the same time, the bar display will disappear, leaving only the bottom segment and a single segment positioned just below MAN RESET. This segment is a cursor to identify the CAL 1 and CAL 2 Modes.

Step 6. Hold the DISPLAY Key in and press the SETUP Key just once. The cursor will now indicate the CAL 1 function, and a number will appear in the top display. The controller is now in the Calibration Mode.

> **NOTE:** If no key is pushed for 1.5 minutes after entering the Calibration Mode, the controller will automatically return to the RUN Mode and will revert to previously stored Calibration Data.

Step 7. Increment the value in the top display using the INCREASE and DECREASE Keys until the display reads the CAL 1 value (2990°F for Range Code 122).

Step 8. Advance the cursor to the CAL 2 position by holding the SETPOINT Key in and pressing the SETUP Key until the cursor reaches the CAL 2 position.

Step 9. Place the thermometer on rear panel terminals 1 and 2 (thermocouple input) of the controller. After the thermocouple temperature indication has stabilized (80°F for this example), continue this procedure.

Step 10. Look up the millivolt equivalent of the above ambient temperature reading in the same EMF versus Temperature Table used in Step 4 (.269 mV in this example). Subtract this value from the millivolt equivalent of the CAL 2 value found in Table 20-1 (30.140 mV minus .269 mV = 29.871 mV).

Step 11. Set the millivolt source to the millivolt value calculated in Step 10 (29.871 mV).

Step 12. Increment the display value using the INCREASE and DECREASE Keys until it reads the CAL 2 value (2990°F for this example).

Calibration is now complete.

Step 13. To leave the Calibration Mode, press the SETUP Key for one second or more. Failure to hold the SETUP Key for one second will result in the loss of the calibration data in the memory of the controller. If this occurs, the top display goes blank and then briefly displays 0 0 0 0 and then recalibration is required.

— WARNING —

If power to the controller is interrupted within 20 seconds after leaving the Calibration Mode, memory data will be lost. To restore memory data, the controller must be returned to either the local branch office or the factory.

20.4 Calibration Procedure for Millivoltage Inputs (400 Series Range Codes)

Step 1. A Millivoltage Source is required. Connect the positive probe (red insulation) and the negative probe of the Calibration Cable Assembly to the source.

Step 2. Push the Calibration Assembly Plus into the front panel Calibration Jack, which is just under the SETUP Key.

Step 3. Find the CAL 1 value for the controller's Range Code in Table 20-2.

Step 4. Adjust the Source to the equivalent of the CAL 1 value.

Step 5. Press the SETUP Key just once. Four dashes will replace the numeric value in the top display, indicating that the controller is ready for you to proceed. At the same time, the bar display will disappear, leaving only the bottom segment and a

single segment positioned just below MAN RESET. This segment is a cursor to identify the CAL 1 and CAL 2 Modes.

Step 6. Hold the DISPLAY Key in and press the SETUP Key again. The cursor will now be opposite the CAL 1 mark and a number will appear in the top display. The controller is now in the Calibration Mode.

NOTE: If no key is pushed for 1.5 minutes after entering the Calibration Mode, the controller will automatically return to the RUN Mode and will revert to previously stored Calibration Data.

Step 7. Increment the value in the top display using the INCREASE and DECREASE Keys until the display reads the CAL 1 value.

Step 8. Advance the cursor to the CAL 2 position by holding the SETPOINT key in and pressing the SETUP Key until the cursor reaches the CAL 2 position.

Step 9. Adjust the Source to the equivalent of the CAL 2 value.

Step 10. Increment the display value using the INCREASE and DECREASE Keys until the value reads the CAL 2 value.

Calibration is now complete.

Step 11. To leave the Calibration Mode, press the SETUP Key for one second or more. Failure to hold the SETUP Key for one second will result in the loss of the calibration data in the memory of the controller. If this occurs, the top display goes blank and then briefly displays 0 0 0 0 and then recalibration is required.

— WARNING —

If power to the controller is interrupted within 20 seconds after leaving the Calibration Mode, memory data will be lost. To restore memory data, the controller must be returned to either the local branch office or the factory.

20.5 Calibration Procedure for Voltage (greater than 50 mV) and Milliampere Inputs

Step 1. Either a Milliampere or a Voltage Source is required.

Step 2. Connect the Source to rear panel input terminals of the 560. Terminal 1 is positive; Terminal 2 is negative. The front panel Calibration Jack *is not used.*

Step 3. Find the CAL 1 value for the controller's Range Code in Table 20-2.

Table 20-2. Calibration Point Data for Range Codes Series 400, 800 and 900

Range Code	Input	CAL 1 & CAL 2 (Reading)
400	16 mV	1600
401	10 mV	10.00
402	25 mV	25.00
403	50 mV	50.00
404	5 mV	5.00
407	50 mV	600
408	50 mV	28.00
409	50 mV	1500
410	13.89 mV	4000
411	50 mV	250.0
412	50 mV	100.0
413	5.84 mV	150
414	20 mV	500
415	50 mV	300
416	35 mV	1300
418	5.309 mV	200
420	10 mV	200
701	20.563	2645
800	10 V	3200
801	100 mV	100.0
802	100 V	100.0
803	5 V	100.0
804	5 V	250.0
805	5 V	300
806	10 mV	10.00
807	10 V	500
808	200 mV	200.0
809	10 V	400
810	10 V	90.0
811	10 V	4.00
812	10 V	500
813	100 mV	0.0
814	5 V	100.0
815	300 mV	300
817	2.5 V	2500
818	3 V	3000
819	100 mV	2000
820	100 mV	2200
821	100 mV	2000
822	4 V	400
823	5 V	400
824	5 V	300
825	100 mV	3500
826	5 V	3000
827	5 V	70.0
828	5 V	140.0
829	10 V	1000
830	75 mV	3000
831	100 mV	1200
832	5 V	150.0
833	5 V	1.50
834	5 V	500
835	5 V	2000
836	5 V	400
837	5 V	1000
900	20 mA	100.0
901	20 mA	2400
902	20 mA	50.0
903	20 mA	14.00
904	20 mA	5.00
905	20 mA	200.0
906	20 mA	300
907	20 mA	5000
908	20 mA	2.700
909	20 mA	400
910	20 mA	2.900
911	20 mA	400
912	20 mA	3000
913	20 mA	1.0
914	20 mA	6.00
915	20 mA	150.0
916	20 mA	500
917	20 mA	100.0
918	20 mA	18.0
919	32 mA	850
920	20 mA	15.00
922	20 mA	1000
923	20 mA	140.0
924	20 mA	.300

Step 4. Adjust the Source to the equivalent of the CAL 1 value.

Step 5. Press the SETUP Key just once. Four dashes will replace the numeric value in the top display, indicating that the controller is ready for you to proceed. At the same time, the bar display will disappear, leaving only the bottom segment and a single segment positioned just below MAN RESET. This segment is a cursor to identify the CAL 1 and CAL 2 Modes.

Step 6. Hold the DISPLAY Key in and press the SETUP Key just once. The cursor will now be opposite the CAL 1 mark and a number will appear in the top display. The controller is now in the Calibration Mode.

NOTE: If no key is pushed for 1.5 minutes after entering the Calibration Mode, the controller will automatically return to the RUN Mode and will revert to previously stored Calibration Data.

Step 7. Increment the value in the top display using the INCREASE and DECREASE Keys until the display reads the CAL 1 value.

Step 8. Advance the cursor to the CAL 2 position by holding the SETPOINT Key in and pressing the SETUP Key until the cursor reaches the CAL 2 position.

Step 9. Allow the Source to remain at the CAL 1 value.

Step 10. If necessary, increment the display value using the INCREASE and DECREASE Keys until the value reads the same value as CAL 1.

Calibration is now complete.

Step 11. To leave the Calibration Mode, press the SETUP Key for one second or more. Failure to hold the SETUP Key for one second will result in the loss of the calibration data in the memory of the controller. If this occurs, the top display goes blank and then briefly displays

0 0 0 0

and then recalibration is required.

— WARNING —

If power to the controller is interrupted within 20 seconds after leaving the Calibration Mode, memory data will be lost. To restore memory data, the controller must be returned to either the local branch office or the factory.

20.6 Calibration Procedure for the RTD Inputs (Range Codes 5XX to 6XX)

20.6.1 FIELD CALIBRATION

Step 1. Measure accurately the temperature sensed by the RTD.

Step 2. Look at the reading displayed by the 560 and write down the offset.

Step 3. Press the SETUP Key just once. Four dashes will replace the numeric value in the top display, indicating that the controller is ready for you to proceed. At the same time, the bar display will disappear, leaving only the bottom segment and a single segment positioned just below MAN RESET. This segment is a cursor to identify the CAL 1 and CAL 2 Modes.

Step 4. Hold the DISPLAY Key in and press the SETUP Key just once. The cursor will now be opposite the CAL 1 mark and a number will appear in the top display. The controller is now in the Calibration Mode.

NOTE: If no key is pushed for 1.5 minutes after entering the Calibration Mode, the controller will automatically return to the RUN Mode and will revert to previously stored Calibration Data.

Step 5. Advance the cursor to the CAL 2 position by holding the SETPOINT Key in and pressing the SETUP Key until the cursor reaches the CAL 2 position.

Step 6. By using the INCREASE and DECREASE Keys, modify this CAL 2 reading by the offset written earlier in Step 2. For example, if the 560 was reading 2°F below the actual RTD temperature, increase the CAL 2 reading by 2°F.

Step 7. To leave the Calibration Mode, press the SETUP Key for one second or more. Failure to hold the SETUP Key for one second will result in the loss of the calibration data in the memory of the controller. If this occurs, the top display goes blank and then briefly displays

0 0 0 0

and then recalibration is required.

— WARNING —

If power to the controller is interrupted within 20 seconds after leaving the Calibration Mode, memory data will be lost. To restore memory data, the controller must be returned to either the local branch office or the factory.

Calibration is now complete.

20.6.2 BENCH CALIBRATION

This calibration procedure is for a Platinum RTD with either a temperature coefficient of 0.00385 Ω/Ω/°C or a temperature coefficient of 0.003911 Ω/Ω/°C.

This is an example of the procedure for a range of 0-300°F for an RTD with a temperature coefficient of 0.00385 Ω/Ω/°C.

The procedure for other RTD's is the same.

From Table 2A in 1113/ES 2-1, which are the Barber-Colman RTD RESISTANCE VERSUS TEMPERATURE TABLES, obtain the following information for this example:

Equivalent Temperature	Resistance in ohms of RTD
0°F	93.03 Ω
300°F	156.90 Ω

Inputs from 3-wire RTD's can be zeroed and spanned on the work bench by means of a Resistance Decade Box which can be adjusted to 0.1 Ω.

Proceed as follows:

Step 1. Connect the Resistance Decade Box to rear panel terminals 1, 2 and 3. See Figure 6-3 and substitute the Resistance Decade Box for the RTD.

Step 2. Calibration Cable Assembly 24-48 consists of a plug connected to a cable and two tinned leads on the end away from the cable. Short the two tinned leads together.

Step 3. Insert the plug into the front panel Calibration Jack of the Model 560 Controller. Shorting the Calibration Jack connects 0 mVdc into the 560 Test Jack; which, in turn, determines the low end of the range of the 560. This low end could be, for example, 0°F, -20°F, -100°F, depending on the range programmed into the 560 Memory at the factory.

Step 4. Press the SETUP Key just once. Four dashes will replace the numeric value in the top display, indicating that the controller is ready for you to proceed. At the same time, the bar display will disappear, leaving only the bottom segment and a single segment positioned just below MAN RESET. This segment is a cursor to identify the CAL 1 and CAL 2 Modes.

Step 5. Hold the DISPLAY Key in and press the SETUP Key just once. The cursor will now be opposite the CAL 1 mark and a number will appear in the top display. The controller is now in the Calibration Mode.

NOTE: If no key is pushed for 1.5 minutes after entering the Calibration Mode, the controller will automatically return to the RUN Mode and will revert to previously stored Calibration Data.

Step 6. Advance the cursor to the CAL 2 position by holding the SETPOINT Key in and pressing the SETUP Key until the cursor reaches the CAL 2 position.

Step 7. Adjust the Resistance Decade Box to the equivalent (93.03 Ω) of the CAL 2 value (0°F in this example).

Step 8. With the calibration jack shorted, increment the display value using the INCREASE and DECREASE Keys, until the value reads the low end of the temperature span for the instrument (0°F in this example).

Step 9. Remove the plug you inserted in the Calibration Jack in Step 3. The unit is now calibrated at the low end (0°F in this example).

Step 10. Push SETUP Key just once to leave the Calibration Mode.

Step 11. With the Resistance Decade Box still at the low temperature value (933.03 Ω in this example) adjust the RTD Calibration Potentiometer on the RTD Input Card until the display indicates the low end of the temperature span for the instrument (0°F in this example).

After each small adjustment of the Potentiometer, wait until the display reaches its new value.

Step 12. Adjust the Resistance Decade Box to the equivalent (156.90 Ω) of the CAL 1 value (300°F in this example).

Step 13. Repeat Steps 4 and 5.

Step 14. Increment the value in the top display using the INCREASE and DECREASE Keys until the display reads the CAL 1 value (300°F in this example). If four dashes appear initially, press the DECREASE Key until numbers appear in the display.

Calibration is now complete.

Step 15. To leave the Calibration Mode, press the SETUP Key for one second or more. Failure to hold the SETUP Key for one second will result in the loss of the calibration data in the memory of the controller. If this occurs, the top display goes blank and then briefly displays 0 0 0 0 and then recalibration is required.

— WARNING —

If power to the controller is interrupted within 20 seconds after leaving the Calibration Mode, memory data will be lost. To restore memory data, the controller must be returned to either the local branch office or the factory.

20.7 Overrange Indication During Calibration

If the input millivoltage is above the instrument span **when entering CAL 1,** the display will show four dashes (----).

If the input millivoltage is increased above the instrument span **while in CAL 1,** the instrument will exhibit one of the following three characteristics.

1. The display reading will be a number **slightly above** the CAL 1 point which may be adjusted easily with the INCREASE and DECREASE Keys. Calibrate normally.
2. The display reading will be a number **above** the CAL 1 point which appears "locked up" (unchanging) and pressing the front panel INCREASE and DECREASE Keys appears to have no immediate effect. To calibrate, press the DECREASE Key and continue to press it, possibly for several seconds, until the display begins to decrease. Calibrate normally.
3. The display reading will appear "locked up" as in (2) above but will not show a number which is **below** the CAL 1 point. To calibrate, **do not** press the INCREASE Key. Instead press, and continue to press, the DECREASE Key. The display will not change, possibly for several seconds, but will then jump quickly to a number which is above CAL 1 point and begin dropping. Calibration may now be performed normally.

The "locked up" condition described in (2) and (3) above results from the normal display update time of approximately two readings per second. When the input is changing very rapidly from a source such as either a portable potentiometer or other millivolt source, the input may go overrange **between** two consecutive Analog-to-Digital Converter readings. When this occurs, the 560 will display and **hold** the last reading which was within the display span. If the input millivoltage is increased rapidly enough, the display reading may be held **slightly above or even below** the desired CAL 1 point. When this occurs, the Analog-to-Digital Converter in the 560 is actually measuring inputs **above** the CAL 1 point but the display remains fixed at a reading which is **below.** Pressing the INCREASE Key to increase this erroneous reading actually causes the calibration to become worse. A point may be reached where the correct calibration may only be obtained after again pressing the DECREASE Key for **several minutes.**

Table 20-3. Calibration Point Data for Each RTD Range Code 500 to 599

Range Code	CAL 1 Point	CAL 2 Point
500	100.0	0.0
501	200.0	0.0
502	300.0	0.0
503	400	0
504	600	0
505	800	0
506	100.0	0.0
507	200.0	0.0
508	300.0	0.0
509	400	0
511	0	-300
512	0.0	-300
513	0.0	-95.0
514	100.0	-95.0
515	200	-200
517	0.0	-95.0
518	100.0	-95.0
520	500	0
523	500	-100
524	100.0	0
525	200.0	-95.0

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